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Boulder City Water
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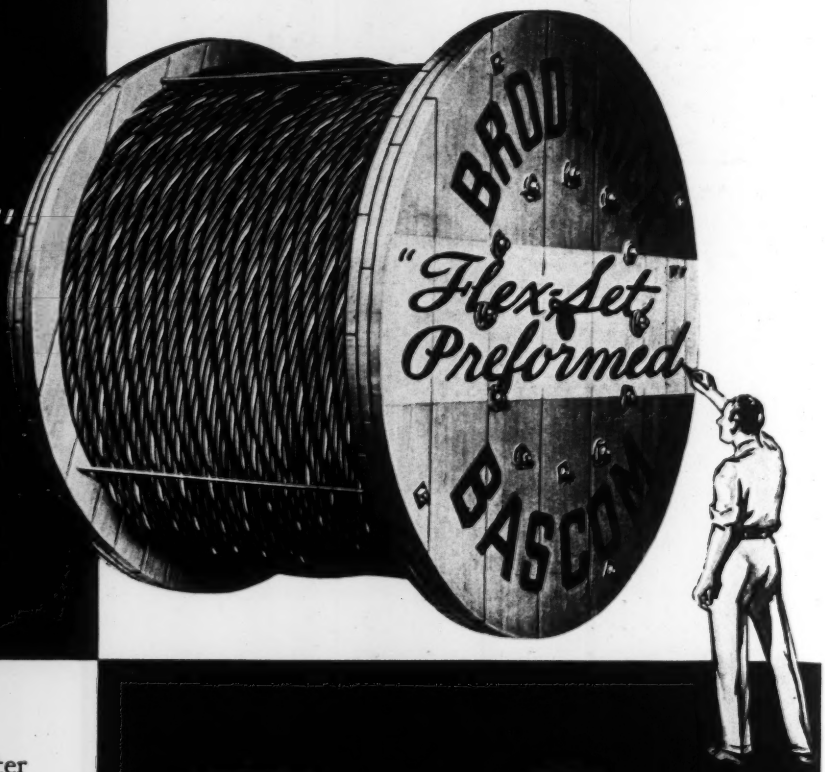

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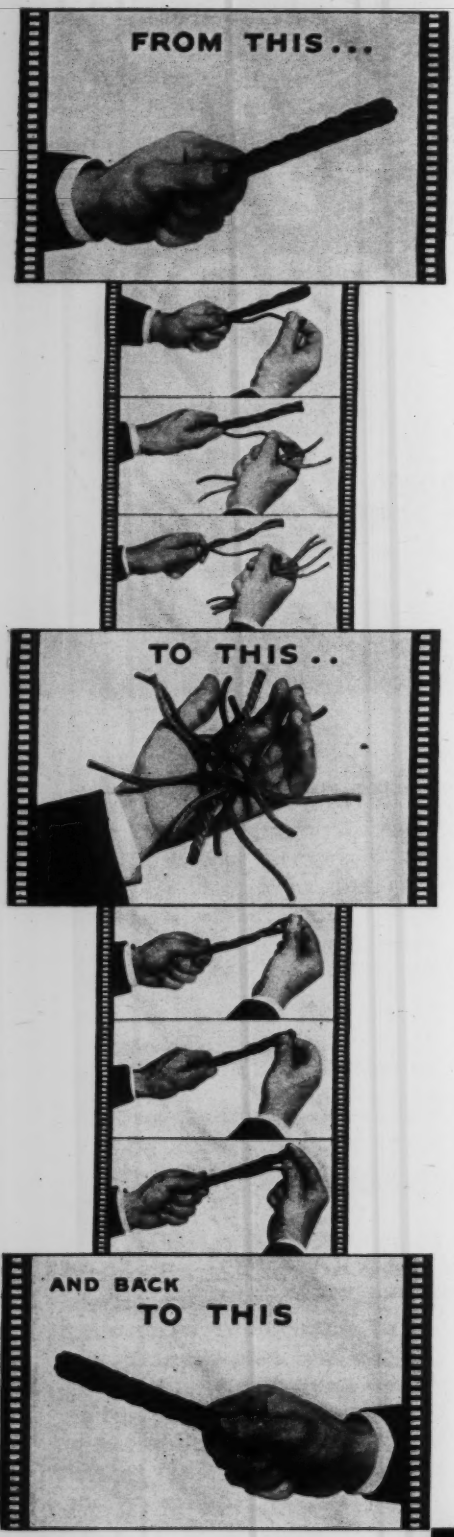

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Worst Water in the West Made Fit to Drink

Treatment of the silt-laden Colorado River water for the Boulder Dam builders involves all the problems of presedimentation, aeration, softening, recarbonation, filtering and chlorination—Desert cloudburst causes a turbidity of 150,000, which was conquered with lime and carbonation

By D. M. Forester

Sanitary Engineer, U. S. Bureau of Reclamation, Boulder City, Nev.

BUILT to make a potable water out of the unbelievably turbid Colorado River, Boulder City, Nev., the construction camp for the Boulder Dam project, has the distinction of being the first community successfully to eliminate the sediment and hardness of one of the flashiest, most turbulent and heaviest silt-laden streams whose waters are used for domestic consumption in the country. Almost consistently a clear water with hardness around 100 p.p.m. has been produced since a treatment plant of unusually modern design started in April, 1932. Essentially the layout consists of presedimentation near the river and chemical treatment in Boulder City, followed by filtration in Boulder City 6.6 miles from the dam site on a waterless desert plateau approximately 2,000 ft. higher than the river level. This difference in elevation necessitated three pumping lifts.

Water characteristics

Studies of the river made prior to the design of the water-supply system showed wide ranges of suspended solids varying from 350 to 59,400 p.p.m. and averaging 6,000 p.p.m. for a yearly period; total hardness varying from 144 to 636 p.p.m. and averaging 367 p.p.m. From information secured since the system has been in operation, the variations have been even greater.

The average mineral content in p.p.m. for a period of two years, 1926-28, was as follows:

Silica (SiO_2)	16.0
Iron (Fe)	0.22
Calcium (Ca)	93.0
Magnesium (Mg)	33.6
Sodium (Na)	118.0
Potassium (K)	6.4
Bicarbonate radicle (HCO_3)	192.0
Sulfate radicle (SO_4)	328.0
Chloride radicle (Cl)	93.0
Nitrate radicle (NO_3)	4.7
Hardness as $CaCO_3$:	
Non-carbonate	209.0
Carbonate	158.0

Pretreatment plant on the side of Black Canyon. The pumping plant at the river is mounted on a carriage that can be adjusted to river levels.

Water with such a wide range of characteristics required a plant with maximum flexibility and one providing complete softening. As designed and built, the system has a maximum capacity of 2 m.g.d. and includes such features as presedimentation, aeration, softening, recarbonation, filtering and chlorination. The first eight months of operation, which includes the period of maximum variations, has proved the design and process entirely capable of handling this difficult water easily.

Divided plant

The system is divided into two distinct parts: the pretreatment plant situated upon the bank of the river about 3,000 ft. downstream from the dam site, and the softening plant at Boulder City. The pretreatment plant consists of the river intake, presedimentation plow-type clarifier, sump tank and high-head pumps that deliver the water to the sec-

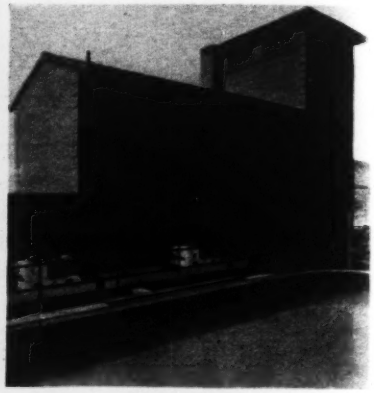
ond pumping station. The river intake includes three 550-g.p.m., 115-ft.-head, centrifugal pumps mounted upon a carriage that can be raised or lowered by a motor-driven hoist upon a 47½ deg. incline to suit the varying stages of the river. Provision is made to draw and discharge water at seven intermediate points between low water at El. 643 and high water at El. 683. These pumps discharge through a 10-in. line into the presedimentation basin, 55 ft. square by 11 ft. side depth. The presedimentation basin is of sufficient size to permit 2.5 hours detention period at the designed flow. From this basin the effluent flows by gravity into a sump tank that supplies the three 450-g.p.m., 1,150-ft. head pumps, which force the water through 3.9 miles of pipe line against a static head of 1,050 ft. to the intermediate pumping station. The pumping equipment at the intermediate pumping station is similar to that at pumping plant 1, and after the starting switches are preset it is entirely automatic in operation. To provide for inequalities of pumping, a regulating or equalizing tank, 90 ft. high, was placed just ahead of the intermediate pumping station. From this station the water is pumped through 2.7 miles of pipe line against a static head of 810 ft. to the aerator at the filtration plant in Boulder City.

Automatic air valves are installed in the pipe line at points of change in grade, and an air vent is provided at a point in the pipe line where it passes over a summit. At each pumping plant automatic surge suppressors protect the line from surges and water hammer. Back flow is prevented by solenoid-controlled automatic check valves.

Following aeration, the water flows by gravity into a 100,000-gal. receiving tank and thence to the treating plant. The design of the treating plant is such that the water may be subjected to simple coagulation, partial or complete softening, depending upon its characteristics. The units are arranged to permit either series or parallel operation. During the first eight months of operation the most satisfactory method of treatment was obtained by plain subsidence at the pretreatment plant followed by excess lime-soda-ash softening, with series flocculation, sedimentation and carbonation.

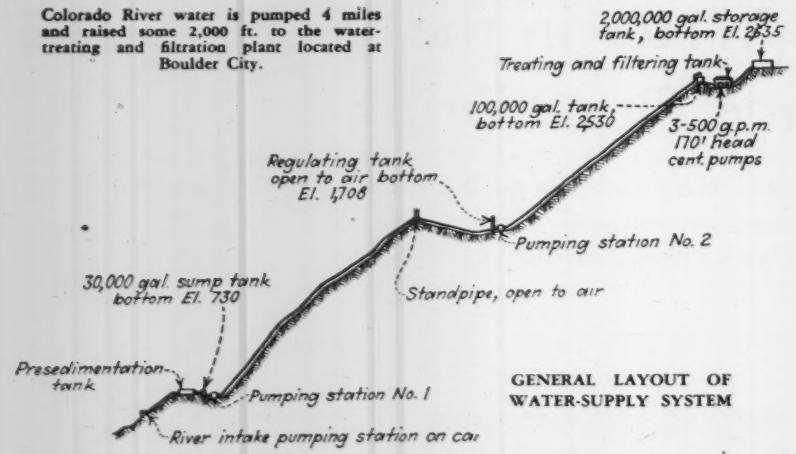
Following plain subsidence at the river plant and aeration at the receiving tank, the water is dosed with hydrated lime and soda ash, then mixed and flocculated in two basins 14 ft. square equipped with mechanical agitators. Primary flocculation is followed by a sedimentation period of two hours in a basin 45 ft. square equipped with the plow type of sediment remover. From this basin the settled water passes to the primary carbonation basin where it is given partial carbonation for a period of 30 min. to convert the causticity, which is in the form of calcium hydroxide, to calcium carbonate. The water then passes to the secondary agitators, thence to the secondary sedimentation basin and into the secondary carbonation basin, where it is given further carbonation to convert any existing carbonates to bicarbonates. It is then filtered through rapid sand filters, chlorinated and pumped direct into the 2-m.g. reservoir with three 500-g.p.m., 160-ft.-head pumps, from which point it is delivered to the distribution system by gravity. The secondary agitators, sedimentation basin and carbonation basins are identical with the primary units.

Generally, for the best results, the chemical addition is regulated so that just sufficient soda ash is added to combine with the non-carbonate hardness and excess hydrated lime in an amount to produce a causticity of from 40 to 55 p.p.m. at the end of the primary sedimentation period, depending upon the

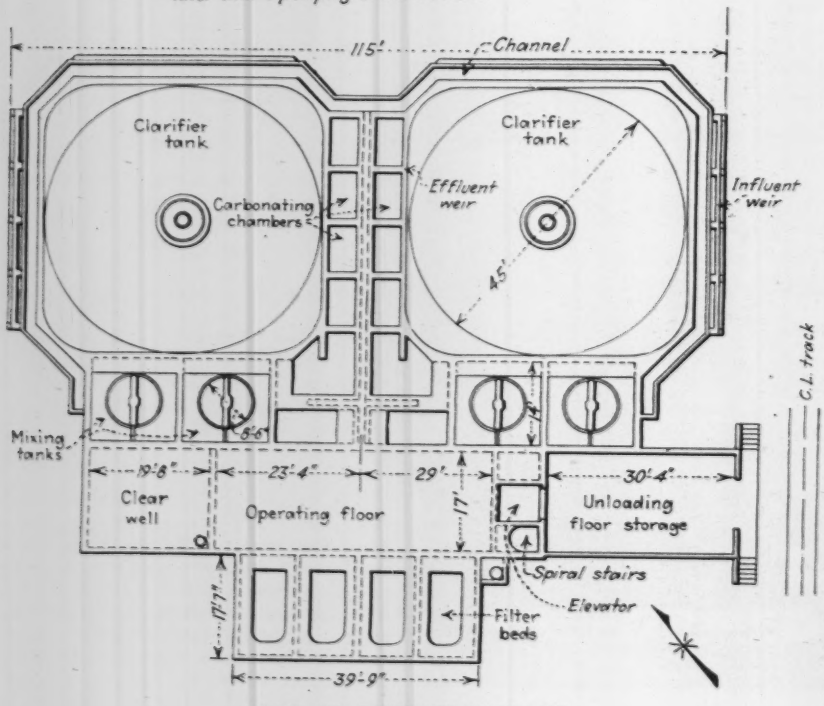


Filtration plant at Boulder City. A wash-water tank is located in the tower. Mixing tanks with motor-driven agitators are placed between the square classifiers and the building that houses the filters.

Colorado River water is pumped 4 miles and raised some 2,000 ft. to the water-treating and filtration plant located at Boulder City.


2,000,000 gal. storage tank, bottom El. 2635
Treating and filtering tank
100,000 gal. tank, bottom El. 2530
3-500 g.p.m. 170' head cent. pumps
Regulating tank open to air bottom El. 1,708
Pumping station No. 2
30,000 gal. sump tank bottom El. 730
Standpipe, open to air
Presedimentation tank
Pumping station No. 1
River intake pumping station on ca

GENERAL LAYOUT OF WATER-SUPPLY SYSTEM



PLAN OF FILTRATION PLANT

TABLE I — RESULTS OBTAINED AT PRESEDIMENTATION CLARIFIER

Month	Aver. Rate Flow, M.G.D.	Turbidity, P.P.M.						Suspended Solids, P.P.M.						Aver. Removal Per Cent
		Influent			Effluent			Influent			Effluent			
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
April	0.74	16,800	5,000	9,050	380	130	230	29,850	8,560	13,120	320	25	130	99.0
May	0.73	6,375	2,360	4,035	800	190	440	14,800	3,670	8,350	425	45	230	97.3
June	1.04	2,500	800	1,325	750	240	415	17,100	4,052	8,807	595	109	246	97.2
July	1.09	19,800	1,000	4,170	16,000	35	917	27,540	1,270	8,460	13,160	34	677	92.0
Aug	1.01	49,200	1,600	11,470	44,000	150	4,386	56,650	2,100	11,600	29,900	87	3,060	73.6
Sept	0.53	150,000	2,100	25,880	57,500	20	10,055	84,400	2,400	16,510	54,040	20	8,000	51.6
Oct	0.63	20,200	1,350	6,080	250	65	160	17,530	1,470	5,440	207	28	92	98.3
Nov	0.66	7,400	800	1,930	185	65	130	6,540	940	2,460	140	35	80	96.7

TABLE II — HARDNESS OF INFLUENT TO SOFTENING PLANT*
(Results in P.P.M.)

Month	Total Hardness as $CaCO_3$			Non-Carbonate Hardness as $CaCO_3$			Carbonate Hardness as $CaCO_3$			Free CO_2†		
	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.
April	365	189	258	193	59	115	172	120	143	12.0	0.0	2.8
May	233	102	156	115	0	45	136	88	111	5.0	1.0	3.6
June	140	100	113	50		21	106	66	92	5.0	0.0	2.6
July	524	124	238	431	27	134	126	88	104	2.0	0.0	0.25
Aug	714	220	352	554	120	224	164	98	128	13.0	0.0	1.0
Sept	904	405	564	651	237	407	177	120	157	11.0	0.0	2.0
Oct	568	450	529	395	288	348	196	162	181	0.0	0.0	0.0
Nov	571	482	521	365	279	317	216	194	204	0.0	0.0	0.0

*Negative non-carbonate hardness occurred twice in May and once in June.
†After passing through Aerator.

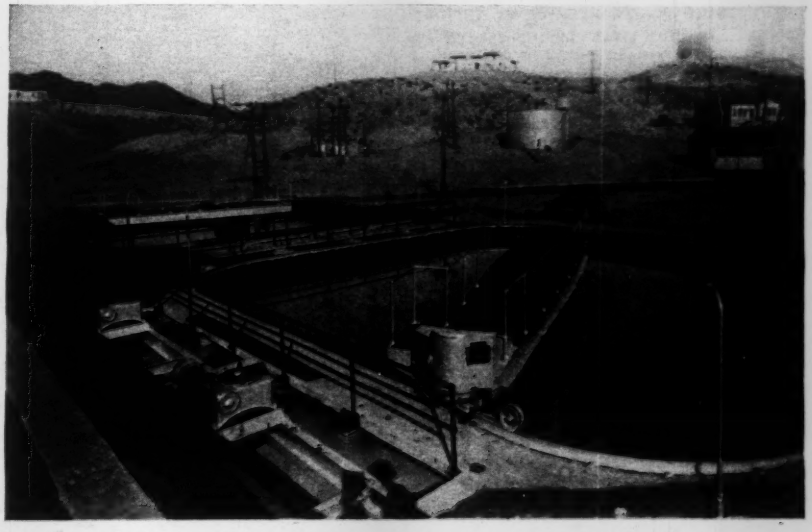
characteristics of the plant influent. Many variations of this treatment have been used as the character of the raw water varied, such as excess lime alone, addition of recirculated sludge, alum or sulphate of iron to either or both primary and secondary mixing basins.

Plant operation

The complete system was placed in operation on March 2, 1932, at which time the consumption was only 0.3 m.g.d. The consumption has steadily increased as Boulder City developed and also as a result of a higher water demand during hot weather. The practice has been to operate the plant intermittently; usually from twelve to sixteen hours a day. Under this method of operation the quantity of water required can be delivered by using one, two or three pumps at each pumping station. Although the total quantity of water treated per day is small, the flow through the plant is at the rate of 0.67, 1.33 or 2.0 m.g.d., depending upon the number of pumping units used.

The operating data on the presedimentation basin, as shown in Table I, gives an idea of the extremely wide ranges in the condition of the river water. The low removal of suspended solids during July, August and September is the result of abnormal conditions of a very few days' duration. The suspended solids during such extreme conditions were almost colloidal in character and were carried down to the river by cloudbursts in various sections of the desert areas in the river basin. However, only in one or two instances (noted later) was difficulty experienced in securing coagulation at the treating plant.

During the period since the treating plant has been in operation, the total hardness of the influent has varied from 904 to 100 p.p.m. Changes occur quickly, and variations of more than 200 p.p.m. total hardness have occurred within a period of three hours. The per cent of carbonate and non-carbonate hardness in the raw water is also subject to frequent and wide variations. Notwithstanding such variable conditions, the treating plant has been able to deliver a clear sparkling water, having an average total hardness of less than 120 p.p.m. As it is desired to deliver a water having a total hardness of only 100 to 125 p.p.m., no attempt has been made to determine the lowest hardness limit attainable. However, in ordinary operation, waters have been produced having a total hardness as low as 53 p.p.m. and an alkalinity of 32 p.p.m.



Mixers, clarifiers, equalizing tank with aerator and 2-m.g.d. tank located on hill at the Boulder City filtration plant.

TABLE III — CHEMICAL CHANGES DURING SOFTENING PROCESS
(Results in P.P.M.)

Mo.	Effluent Primary Clarifier								Effluent Primary Carbonation								Effluent Secondary Clarifier								Effluent Secondary Carbonation							
	H	M	P	CO_2	pH	Hy	Cb	Bi	H	M	P	CO_2	pH	Hy	Cb	Bi	H	M	P	CO_2	pH	Hy	Cb	Bi	H	M	P	CO_2	pH	Hy	Cb	Bi
Apr	86	91	67	0	10.7	43	48	0	82	85	49	0	9.7	13	72	0	75	77	44	0	9.7	11	66	0	84	80	0	2.5	7.0	0	0	80
May	89	59	43	0	....	27	32	0	82	49	26	0	9.6	3	46	0	85	41	14	0	9.6	0	28	13	88	46	0	4.0	7.1	0	0	46
June	72	52	37	0	....	22	30	0	68	49	26	0	9.6	3	46	0	65	40	19	0	9.6	0	38	2	72	43	0	3.5	7.3	0	0	43
July	104	70	46	0	....	22	48	0	94	64	32	0	9.6	0	64	0	92	54	26	0	9.6	0	52	2	103	60	0	2.0	7.7	0	0	60
Aug	144	69	48	0	....	27	42	0	135	61	29	0	9.6	0	58	3	112	53	24	0	9.6	0	48	5	121	64	0	4.0	7.6	0	0	64
Sept	129	96	68	0	10.7	38	30	0	129	96	49	0	9.6	2	94	0	119	82	40	0	9.6	0	80	2	127	90	0	4.0	7.6	0	0	90
Oct	123	79	59	0	10.7	40	39	0	117	67	35	0	9.6	3	64	0	116	62	31	0	9.6	0	62	0	124	71	0	5.0	7.3	0	0	71
Nov	117	84	63	0	10.8	42	42	0	111	72	37	0	9.6	2	70	0	110	68	34	0	9.0	0	68	0	116	75	0	4.0	7.6	0	0	76

Note: — H = total hardness; M = methyl orange alkalinity; P = phenolphthalein alkalinity; pH = hydrogen-ion concentration; Hy = hydroxides; Cb = carbonates; Bi = bicarbonates.

Table II gives the hardness characteristics of the treating-plant influent.

Chemical characteristics

The various chemical changes occurring during the stages of the softening process are shown by the monthly averages in Table III. The alkalinities shown for the effluent from carbonation basin are higher than desired or contemplated in the original design. Numerous methods have been tried in an effort to effect a further reduction, but none has proved entirely satisfactory. A small dosage of alum has proved more effective and satisfactory than any other method. The small amounts of free CO_2 in the plant effluent have not caused complaints, but the consumers have objected to the "flatness" when there has been a small amount of phenolphthalein alkalinity. The average monthly reductions in hardness and alkalinity are shown in Table IV. Average chemical dosage, with corresponding reduction in effluent, is shown in Table V.

The seasonal variations in the raw water are reflected in the percentages by which the hardness was reduced. The period of minimum hardness occurs during late spring and early summer which is the flood period when the river is swelled by melting snow and rain waters in its upper reaches. Maximum hardness occurs late in the fall and winter months during the period of low discharge. The flashy periods occur during the summer months and are caused by heavy rains or cloudbursts in various sections of the river basin, especially in the desert areas.

Recirculation of sludge

Prior to October various methods were tried in order to effect additional precipitation, over plain sedimentation, of the suspended carbonates in the secondary sedimentation basin by using coagulants and return sludge. However, not one of the combinations of the various methods tried effected as great a removal as was desired. The method now being used was started in October and has been found to be satisfactory. It consists of recirculation of sludge from the primary sedimentation basin to the primary agitators and involves maintaining a hydroxide content in the primary settling-basin overflow of 50 to 55 p.p.m. The effectiveness of this process or method undoubtedly is due to superior flocculation caused by the returned sludge and larger floc formation due to carbonation of the higher hydroxide content. Other benefits have been secured by this method, as shown by the following results under actual operating conditions, using the monthly averages for November and for one day of the month (Nov. 8) during which the sludge was not recirculated.

Filter-operating gallery with chlorine room and laboratory at far end.

	Plant Influent Monthly Aver.	Plant Influent Nov. 8 Aver.	Plant Effluent Monthly Aver.	Plant Effluent Nov. 8 Aver
Total hardness...	521	518	115	154
Non-carbonate hardness.....	317	320	37	54
Carbonate hardness.....	204	198	78	100

The chemical dosage for the one day was upon the same basis as during the

Relation of hardness to streamflow of Colorado River during 1932.

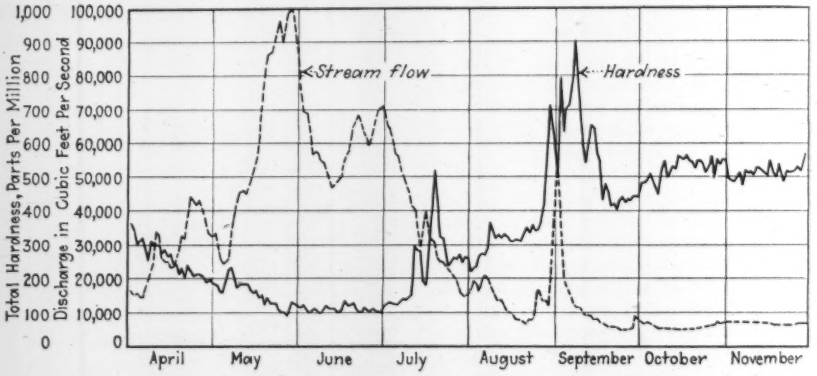


TABLE IV — AVERAGE MONTHLY REDUCTIONS IN HARDNESS

Month	Plant Influent, P.P.M.			Plant Effluent, P.P.M.			Per Cent Reduced		
	Total Hardness	Non-Carbonate Hardness	CarbonateHardness	Total Hardness	Non-Carbonate Hardness	CarbonateHardness	Total Hardness	Non-Carbonate Hardness	CarbonateHardness
Apr.....	258	115	143	84	4	80	67.4	96.5	44.0
May.....	156	45	111	88	42	46	43.6	0.66	59.0
June.....	113	21	92	72	29	43	36.3	38.0	53.3
July.....	238	134	104	103	43	60	56.0	68.0	42.3
Aug.....	352	224	128	121	57	64	65.7	76.4	50.0
Sept.....	564	407	157	238	167	71	57.8	59.0	54.9
Oct.....	529	348	181	126	47	79	76.4	86.4	56.4
Nov.....	521	317	204	115	37	78	78.0	88.3	61.8

TABLE V — CHEMICAL OPERATING RESULTS

Month	No. Gal. Treated, M.G.	Lime, Lb./M.G.	Soda-Ash, Lb./M.G.	Alum, Lb./M.G.	Coke, Lb./M.G.	Lime Data		Soda Ash	
						Lb./M.G. Per P.P.M. Alkalinity Reduced	Lb./M.G. Per P.P.M. Total Alkalinity	Lb./M.G. Per P.P.M. Non-Carbonate Hardness Removed	Lb./M.G. Per P.P.M. Total Non-Carbonate Hardness
April.....	9.507	1,699	1,257	...	573	26.9	11.9	11.3	10.9
May.....	10.106	1,365	143	188	495	21.0	12.3	48.0	3.2
June.....	15.859	1,088	...	64	328	22.2	11.8	....	....
July.....	18.725	1,233	900	20	331	28.0	11.9	9.9	6.7
Aug.....	18.963	1,877	1,571	80	420	29.3	14.7	9.4	7.0
Sept.....	15.124	3,640	1,765	463	487	42.3	23.2	7.3	4.3
Oct.....	12.304	2,568	3,327	...	658	25.2	14.2	11.0	9.6
Nov.....	12.323	2,791	2,795	124	636	22.1	13.7	10.0	8.8

other days throughout the month. By this method of sludge recirculation there is indicated a saving of 96 per cent, or 139 lb. of hydrated lime, and 97 per cent, or 390 lb. of soda ash per m.g. of water treated.

The methods of treatment have produced a water of excellent filtering qualities, as may be noted from the following average filter runs:

	Hours		Hours
April	54.6	August	46.0
May	39.2	September	....
June	45.8	October	81.0
July	51.0	November	69.0

Although the excess-lime, soda-ash treatment has been found efficient in sterilizing the water, for absolute safety a small quantity of chlorine is added to produce a residual of 0.1 to 0.2 p.p.m. after 20 minutes of contact.

Cloudburst water

A most unusual condition occurred at Boulder City during part of August and September, and it presented a very difficult water-treatment problem. In the last three days of August the characteristics of the suspended matter and dissolved solids in the Colorado River underwent a marked change. The suspended matter became much finer than usual, and the amount carried by the river became greater. Only a small amount of the solids was removable by plain subsidence, even at detention periods as long as 7½ hours. Lime, soda ash, alum and other chemicals were tried in an attempt to coagulate the solids, but it was impossible to flocculate the material. Consequently, very little of the suspended material was removed, either at the presedimentation plant or at the treating plant. Most of it was carried to the rapid sand filters. Filter operation was reduced to ½-hour runs, and considerable of the material passed through the filters. More water was required to wash the filters than passed through them.

On Aug. 27 the suspended solids in the raw river water rose to 41,000 p.p.m. from 5,200 p.p.m. on the 26th, and increased to 84,400 p.p.m. on Sept. 1. On Sept. 5 they decreased to 70,530 p.p.m. The total hardness gradually rose from 369 p.p.m. on Aug. 26 to 714 p.p.m. on the 29th, and then to a maximum of 904 p.p.m. on Sept. 7. The turbidities varied from 34,000 on Aug. 26 to 150,000 on Sept. 5, and then slowly decreased to 15,000 on Sept. 11. The coefficient of fineness gradually dropped from 1.19 to 0.24 and then increased to 0.73 on the foregoing dates.

On Sept. 4, following a series of experiments made by Earl M. Kelly, engineer for the Dorr Company, Inc., and the writer, the plant was placed in operation, using a modified and unusual treating process which satisfactorily handled the water. On Sept. 5 the influent to the presedimentation basin contained 70,530 p.p.m. of suspended solids. This influent was given a normal dose of lime, and a removal of 38,570 p.p.m. was effected. The treating-plant influent, containing 31,000 p.p.m. suspended solids, was dosed with sufficient lime to produce a hydroxide content of more than 250 p.p.m. in the effluent from the primary settling basin. Floc formation in the primary basin was practically negligible, and the overflow contained approximately 19,000 p.p.m. The effluent was given a heavy CO_2 treatment in the primary carbonation basin, with a resultant heavy floc formation of 5.5 ft. per hour settling rate. The heavy calcium carbonate floc was extremely efficient in sweeping down the colloidal material and gave a clear overflow. A slight dose of alum was given the flocculated water just ahead of the secondary mixers to expedite the removal of the fine material. As a result of this unusual procedure, the heavy material settled out completely in the secondary settling basin, and the overflow from this unit was as clear as usual and could be handled satisfactorily through the filters without undue loss of head or filter washing. During this period all attempts to use soda ash for softening were discontinued, as it was found that it retarded or prevented floc formation.

Personnel

The designs for the Boulder City water-supply system were made by the Denver office of the Bureau of Reclamation under the direction of L. N. McClellan, chief electrical engineer. Burton M. Lowther, consulting engineer, Denver, worked out the general plan of treatment and assisted in the preparation of designs for the water system. All designing work is under the direction of J. L. Savage, chief designing engineer. All engineering and construction work of the Bureau of Reclamation is under the general direction of R. F. Walter, chief engineer, whose headquarters are at Denver. All activities of the bureau are under the general direction of Elwood Mead, commissioner, Washington, D. C.

Data on Castlewood Dam Failure and Flood

Dam structure and prior history—Flood runoff and discharge—Flood damage and future flood possibilities

By John E. Field
Consulting Engineer, Denver, Colo.

STUDY of flood stages and other records obtainable since the failure of the Castlewood Dam on Aug. 3 *(ENR, Aug. 10, 1933)* discloses significant quantitative data bearing on causes and effects. These data in some parts repeat information given in the account in our issue of Aug. 10, 1933, p. 179, but most of them are new and help materially to round out the technical understanding of flood magnitudes and torrential speeds. The writer of the article speaks with familiarity gained from careful examinations made in preparing a report in 1932 on the control of Cherry Creek floods. —EDITOR.

CASTLEWOOD DAM crossed Cherry Creek just below the confluence of the West and Main forks with a drainage area above the dam of 165 square miles. At Denver, 35 miles below the dam where the stream enters the South Platte River, the drainage area is 413 square miles; and 15 miles above Denver, where a detention dam has been proposed, it is 350 square miles. The drainage area is steeply rolling and is covered with heavy sod or scrub pine. In addition, the site of the dam is in a box canyon with precipitous sides. The runoff is therefore rapid, although the loam soil absorbs water readily. Cloudbursts are common and floods are to be expected, although in the past they have come from only small parts of the total drainage area.

A description and a drawing of a section of the dam were published in *Engineering News-Record*, Aug. 10, 1933. It was designed by A. M. Welles, who, before construction, was displaced by a "practical man," with a recently graduated engineer as chief engineer. The dam was built in 1899-'90. Although built apparently on Mr. Welles' design, the dam was not carried to bedrock but rested in part on large boulders underlain by sand. The Welles plan called for an earthfill on the upstream side, but this was not placed until 1899 under circumstances to be noted later.

As originally constructed, the dam had an upstream wall, with a batter of 10 on 1, of rubble laid in mortar. This wall was about 70 ft. in maximum height, about 60 ft. high above streambed and was about 8 ft. thick. Against the downstream face of this wall was placed a fill of moderate-size stone and quarry waste, with a downstream slope of 1 on 1, which was paved with rubble laid in 2-ft. steps and grouted with cement mortar. An apron of concrete and rubble masonry extended downstream from the toe of the dam, but there was no wall carried to bedrock.

On two occasions blowouts of piping under the dam caused trouble. The first, in 1897, was repaired with selected

stone laid in cement mortar, the repaired wall being carried to bedrock. The second blowout in 1899 was repaired like the first, and, in addition, an earthfill was placed against the upstream wall of the dam. This fill had an upstream slope of 1 on 3 and was riprapped. The outlet pipes were extended upstream through the new fill. No further blowouts have occurred.

Flood runoff

The runoff of the Aug. 3 flood came mostly from the Main and West forks in the probable proportions of 70 per cent and 30 per cent. As estimated and roughly measured, the rainfall on the watershed was from 6 to 9 in. Following two days' rain of considerable volume, the heavy rain lasted from 9 p.m., Aug. 1, to 1 a.m., Aug. 2. As indicating the severity of the storm, the following observations are available.

On Antelope Creek, which flows into the West Fork, there was a steel bridge of 75-ft. span and 12 ft. high to the stringers; the water rose some 3 ft. higher and passed over the bridge floor. The channel was fairly straight and unobstructed for about 1,000 ft. above and 500 ft. below the bridge. The fall is 50 ft. or more per mile, or 10 ft. in 1,000 ft. Considerable water passed over the road at either end of the bridge for a total distance of 600 ft., averaging 2 ft. deep. Taking the cross-section as 12x75 ft., or 900 sq.ft., and the velocity at the very moderate rate of 10 ft. per second, it is certain that 10,000 sec.-ft. ran off the 30 square miles of the drainage area, or 333 sec.-ft. per square mile.

Again, at another bridge above (this one with a drainage area of about 15 square miles, the truss bridge was 420 ft. wide, the water 10 ft. deep and the velocity the same, indicating a flow of 4,000 sec.-ft. Here also much water passed over the roadway. The maximum runoff from these smaller areas indicates the severity of the storm and that more than 146 sec.-ft. per square mile (estimated by the state engineer) is in a way verified. The state engineer in his account of the flood said:

"The following account of what happened immediately preceding the failure has been furnished by H. E. Paine, who had been in charge of the dam for the past twenty years. He states that at about 11:15 p.m. on the night of Aug. 2 the water was 6 ft. below the spillway. (At this elevation there would be 2,500 acre-ft. in the reservoir, with a maximum depth of water of 42 ft.). Following what appears to have been an unusually heavy precipitation over a large portion of the drainage area above the reservoir and surmising that there would be a great inrush of water to the reservoir, he dressed and went down to the dam but a few hundred feet away from his home and found that the water had raised to the top of the dam by 12 midnight. By 12:15 a torrent of water was pouring over and through the dam, and within a few minutes the surface of the reservoir had dropped 13 ft. below the spillway.

"The lapse of time between the inrush of water into the reservoir and the time of the dam failure, according to Mr. Paine's statement, did not exceed 45 min. In this period the dam was overtopped the full length thereof to a depth of about 1 ft., which caused a discharge through the spillway of a depth of 5 ft., estimated to have been 3,000 cu.ft. per second. At the same time the discharge over the remainder of the crest of the dam approximatd 2,500 to 3,000 cu.ft. per second, making a total flow of from 5,500 to 6,000 cu.ft. over the dam."

From this it appears that 2,000 acre-ft. accumulated in the reservoir in 60 min.—that is, 1,000 acre-ft. to spillway level and 1,000 acre-ft. above that point; and, in the same time, from nothing to 5,000 sec.-ft. was being discharged. As 2,000 acre-ft. in 60 min. (11:15 to 12:15) equals 24,000 sec.-ft., it seems safe to say that more than 25,000 sec.-ft. flowed into the reservoir at the crest of the flood, or more than 146 sec.-ft. per square mile. As to the amount that flowed out, the reservoir at 5 ft. above the spillway contained about 4,000 acre-ft. It emptied in one hour; the average discharge over 1 hour was therefore 48,000 sec.-ft. plus at least 15,000 sec.-ft. inflow, making 63,000 sec.-ft. There is some question of the capacity of the reservoir, as it has filled somewhat with sediment; but it seems reasonable to say that 70,000 sec.-ft. approximated the maximum discharge.

Cause of break

The cause of the break cannot be exactly known. The dam had in 1924 overflowed almost to the full spillway depth; it had overflowed several times at lesser depths. There was no blowout. Either the top crumbled or the toe crumbled. Considering the nature of the riverbed at the toe, it is reasonable to say that the toe failed, that the force of the water carried the loose rock away rapidly and pressure broke the rubble masonry.

It may be that some of the steps of the lower rockfill slope loosened and that disintegration of the rockfill resulted, so that the gap widened rapidly. Expansion and frost action, in a period of 33 years might well have weakened the cement joints in the steps, but the writer is convinced that the toe failed first and that if it did not, it would have failed during the flood, even though the steps held. This opinion is confirmed by the statement in the report of Mr. Hinderlider, the state engineer:

"Mr. Paine, caretaker at the Castlewood Dam, is of the opinion that the runoff into the reservoir, which had a capacity of 3,434 acre-ft. and a content of about 2,500 acre-ft. just prior to the flood, was much greater than ever known. He states that in the greatest flood of 1924 the water flowed through the spillway in the dam to a maximum depth of 4 ft. but did not overtop the dam. At that time the discharge over the dam caused considerable vibration in the structure but resulted in no visible damage, with the exception of causing an erosion at the lower end of the spillway about 4 ft. in depth. At other times he had observed discharge over the spillway to a depth of 2 ft. for several hours' duration."

Flood damage

But two lives were lost, some 50 head of livestock were drowned, mud was spread in the Denver streets adjacent to the creek, and some cellars were flooded. The total damage has been stated as $1,000,000, although this seems high.

Though the dam failed at midnight, it was 2:30 a.m. when the flood reached Parker, about 11 miles below, and 5:30 a.m. when it reached the city limits, 25 miles below. About 20,000 sec.-ft. passed through the walled section of the creek in the city. Had the bridges in the city been higher or the creek bed paved, the 20,000 sec.-ft. would probably have remained within the channel. The walled portion of the creek channel is 80 ft. wide and will carry a 12-ft. depth of water.

Better bridges needed

With only about 140 square miles producing the flood, and the drainage area being 404 square miles above the city, it is obvious that under certain conditions this flood will be greatly exceeded. The greatest flood of which there is record was in 1912, when 12,000 sec.-ft. passed through the city. Low bridges and debris caused overflow and damage. Since 1912 the channel conditions have been improved, hence the decrease in damage in the greater flood of 1933. The gaging station, about ½ mile below the mouth of the creek, indicated a crest flow at that point of 16,000 sec.-ft.

Such bridges as were destroyed in and above the city were both obsolete and inadequate for traffic or for a proper waterway. Their destruction will bring about the construction of more practical bridges.

Fire Hydrants at the Century of Progress

Fire hydrants on the water system of the century of Progress grounds, as described in *ENR*, March 2, p. 276, are of the patented safetop design made by Kennedy Valve Manufacturing Co. The nozzle threads on these hydrants are in conformity with the Chicago standard, and confusion arose in describing the whole hydrant as of the Chicago type, which is a hydrant specially designed by the bureau of engineering, water department, city of Chicago.

Beach-Erosion Studies by Federal Board

AFTER two and a half years of experimentation, the Beach Erosion Board of the U. S. War Department has just brought together its preliminary findings in an interim report, dated April 15, 1933. It presents data on current velocities near the shore, sand movement, rate of erosion along the normal beach and at inlets, and the action of groins; some of the results are briefly summarized below. The investigations are being continued.

Beach erosion and protection have had little systematic attention until recently. In 1929 the chief of engineers of the War Department appointed a board on sand movement and beach erosion to study special problems in connection with federal work. The River and Harbor Act of 1930 directed the Secretary of War to study "means of preventing erosion of shores of coastal and lake waters by waves and currents" in cooperation with state agencies, and prescribed a board of seven (four army engineers and three civilians from state cooperating agencies). This board, appointed in September, 1930, reported on the specific problem of beach erosion at Fort Fisher, N. C., in November 1931, (House Document 204), and has now reported in more general terms in the interim report (not printed). It may be noted that beach problems on federal property are under the jurisdiction of a special body, the Shore Protection Board, which consists of the four army members of the Beach Erosion Board.

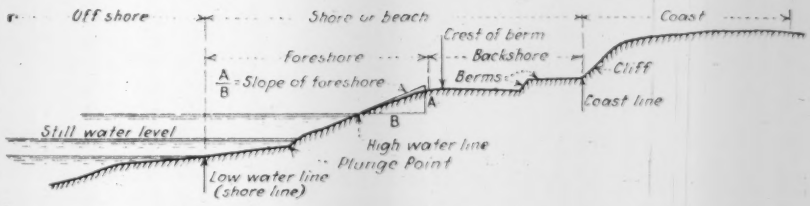


Fig. 1—Characteristic points and zones of typical beach, with nomenclature adopted by Beach Erosion Board.

Principal attention has been given to the beach territory of New Jersey, where many protective works have been built, some by private owners or towns, and some jointly by towns and the State Board of Commerce and Navigation. Beach conditions along the 134-mile length of the New Jersey oceanfront were considered favorable for study. The Board of Commerce and Navigation (1922 report) found by comparing old and modern surveys, that from 1840 to 1920 an average net erosion of 153 ft., or about 2 ft. per year, had occurred along the state's coast line. This figure, in the opinion of the Beach Erosion Board, means that "the balance between erosion and accretion along the New Jersey frontage is close enough to justify the expectation that it can be altered, in most cases at least, by artificial means." Further, as the larger part of the New Jersey frontage is barrier beach (only the extreme northerly and southerly portions—Long Branch to Bay Head and Wildwood to Cape May—being headland) the board is not convinced that the indicated recession of the beach is actual erosion or loss of land area, as it may be merely a bodily shift of the barrier beaches toward the mainland.

The investigations of the Beach Erosion Board were carried out by various methods, some involving rather elaborate experimental equipment. The studies comprised current and wave movement, the translation of sand to and from the beach as well as along the beach, beach profiles, size of sand, volume of sand movement along the shore, nature of sand movement at inlets and the effect of groins in arresting littoral drift. Sand movement was observed by divers and by visual inspection from the surface, and was measured by water sampling. Currents were studied by floats and by special small-sized current meters (*Trans. Am.Soc. C.E.*, 1931, p. 800) which measured both forward and backward currents. Beach slopes and sand sizes were measured.

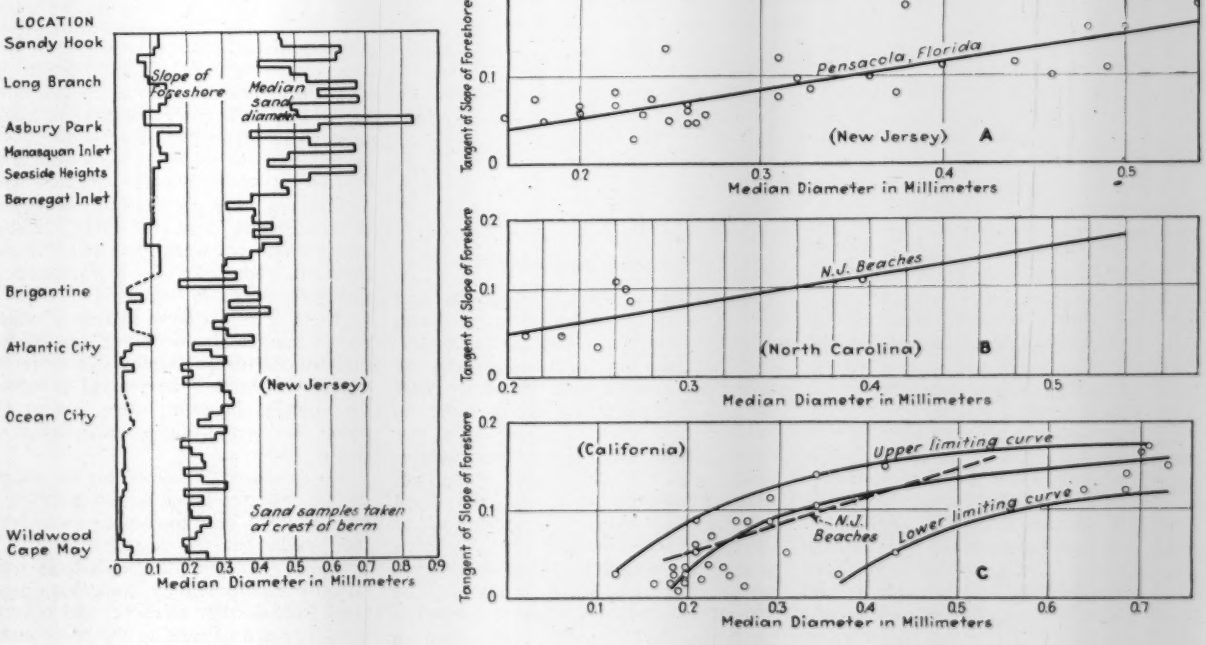


Fig. 2—Observed relation between sand diameter and foreshore slope. Sand size defined as medium diameter, i.e., the diameter exceeded by 50 per cent of the sand by weight.

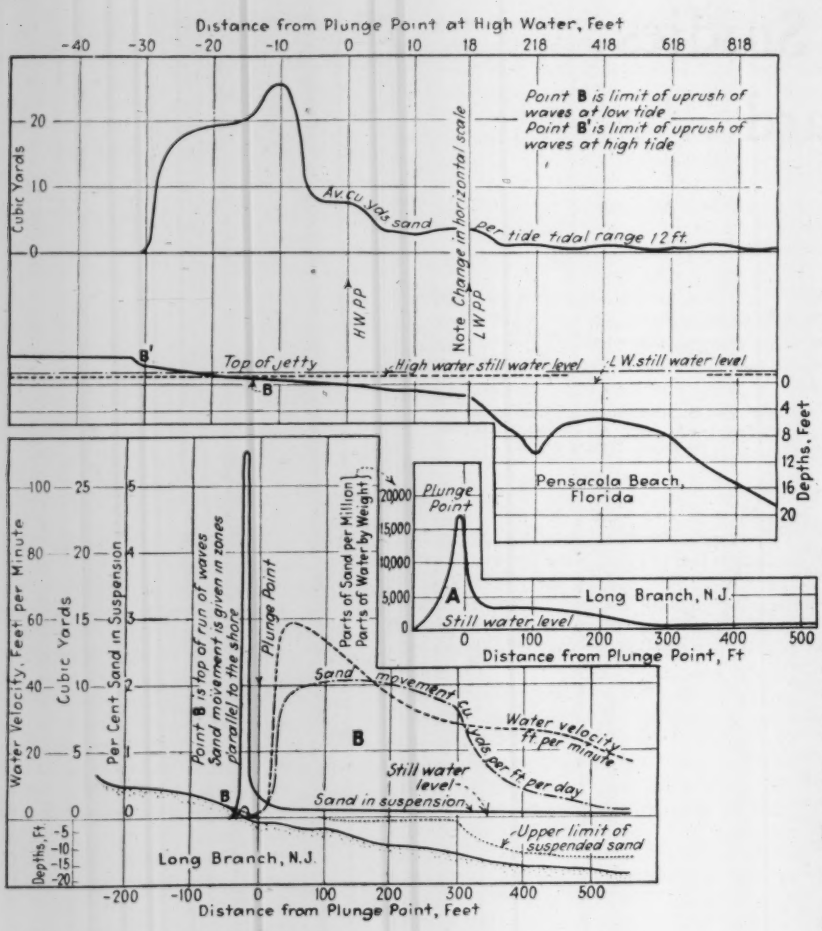

Distance from Plunge Point at High Water, Feet
-40 -30 -20 -10 0 10 18 218 418 618 818
Cubic Yards
Point B is limit of uprush of waves at low tide
Point B' is limit of uprush of waves at high tide
Av. Cu. yds sand per tide tidal range 12 ft.
Note Change in horizontal scale
H.W.P.P.
L.W.P.P.
Top of jetty
High water still water level
L.W. still water level
Depths, Feet
Pensacola Beach, Florida
Plunge Point
Parts of Sand per Million Parts of Water by Weight
Long Branch, N.J.
Still water level
Distance from Plunge Point, Ft
Water Velocity, Feet per Minute
Cubic Yards
Per Cent Sand in Suspension
Point B is top of run of waves
Sand movement is given in zones parallel to the shore
Sand movement Cu. yds per ft. per day
Water velocity ft. per minute
Still water level
Sand in suspension
Upper limit of suspended sand
Long Branch, N.J.
Distance from Plunge Point, Feet

Fig. 3—Amount of sand suspended and moved in longshore drift.

Groin and bulkhead protection were studied both in nature and on models.

Beach profile and sand size

The board uses a special nomenclature to define the principal beach features, as shown in Fig. 1. The shore or beach is defined as extending landward to the extreme limit of wave action, while the foreshore is defined as that section from the low-water line to the top of the foreshore slope or crest of berm. The slope of the foreshore is measured by the tangent at the high-water line.

Elaborate measurements of sand sizes in relation to foreshore slope are summarized in the plottings grouped in Fig. 2. The diagram at the left shows by two irregular lines the variation of foreshore slope and median sand diameter in 195 samples taken at various points along the New Jersey coast; it indicates that the beach is steepest in the general vicinity of Asbury Park and flattens thence northward and southward, and that the sand diameter decreases correspondingly, the finest sand being found where the beach is flattest. It should be noted that the prevailing litteral currents and sand drift are northward along the northern part of the New Jersey coast and southward along the southern part, the approximate dividing point being placed near Seaside Heights, some distance south of Asbury Park.

Another group of New Jersey samples, selected and graded by a uniform procedure, gave the result plotted in curves A, B and C of Fig. 2, A showing a fairly regular straight-line increase of foreshore slope with sand diameter. The plotted points include one from Pensacola, Fla. The points in curve C of Fig. 2 were reported by Prof. M. P. O'Brien from California samples, selected in a different manner from the Eastern samples.

Currents and waves

Numerous studies of currents and wave movements were made by floats, weighted wood balls and current meter. The currents that were measured included tidal, wind and longshore currents. Tidal currents were found to reach a maximum of about 5 ft. per minute, and by summing up the measurements over 60 tidal cycles a residual offshore current of almost the same velocity was found. Observations of wind-generated currents near the beach were inclusive, current direction showing no relation to wind direction. The current parallel to the shore measured by daily float measurements over a period of about a year at a point 10 to 15 ft. seaward of the plunge point, averaged about 30 ft. a minute, with a maximum of about 240 ft. per minute.

Current meter and float observations were made to determine the velocities and paths of motion of water particles in waves at various depths. A total of 1,100 observations under varying weather conditions showed average velocities of 1.33 ft. per second onshore and 1.29 ft. per second offshore, but maximum instantaneous velocities were frequently as great as 5 ft. per second, a figure well above the minimum velocity necessary to move fine sand.

Wave-impact measurements made by the board appear to have yielded no conclusions, as results are not reported.

Sand movement

Movement of sand along the foreshore was studied by filling with red sand a trench at right angles to the beach line, extending from crest of berm to mean sea level, thus giving a definite contrast with the white beach sand. In quiet weather little of the red sand was moved, but on the contrary it was covered by deposits of local sand often as much as 2 ft. In rougher weather, when general beach erosion occurred and there was a marked littoral current with velocities up to nearly 2 ft. per second, the red sand was eroded at the plunge point and carried along the beach, where it could be traced for distances of 200 to 500 ft.

Under water the longshore movement of sand decreased in amount, according to a diver's observations, as the distance from shore and the depth of water increased, but the movement was not all of the same character. Close to shore the sand was raised from the bottom by passing waves, and the longshore drift then carried the suspended sand along; in deeper water only slight surface disturbance of the sand was observed. Surveys of the bottom by sounding, carried over a considerable period of time and for distances of many hundred feet from the shore, showed that the bottom was in constant motion, both in regions where definite offshore bars or terraces were present and in regions of continuous seaward slope. Large sand movements were indicated. In one instance, about 800 ft. from shore in an 18-ft. depth of water, a change in depth of 5 ft. occurred during 21 days, and "Changes also occurred beyond this limit in still deeper water still more remote from shore." In general, however, the changes in depth were less as the point of observation was farther from shore.

No data were obtained on the source of the moving sand or on permanent movement of sand toward or away from the beach, but the board says, "It is probable that the littoral drift is periodically reinforced by contributions of sand from farther offshore, and reduced by the return of sand to the more stable

zones farther offshore. If this occurs, it is probably in an erratic fashion." Erosion often synchronizes with the formation of offshore bars, and beach accretion with destruction of such bars. However, the board concludes that, "the sea bottom offshore cannot be counted on as a source of beach-building material."

The amount of sand placed in suspension by wave action was observed by sampling over a zone extending from 5,000 ft. offshore to the beach, at various distances from the bottom and in different locations, during a period of three years covering many weather conditions. The sand content increased rapidly with increase of wave height and with proximity to the bottom. Plotted with respect to distance from the plunge point, the observations gave the average curve *A* in Fig 3, showing about 17,000 parts per million (by weight) at the plunge point, 4,000 p.p.m. 25 ft. seaward of this point, and less than 1,000 p.p.m. beyond the 275-ft. point.

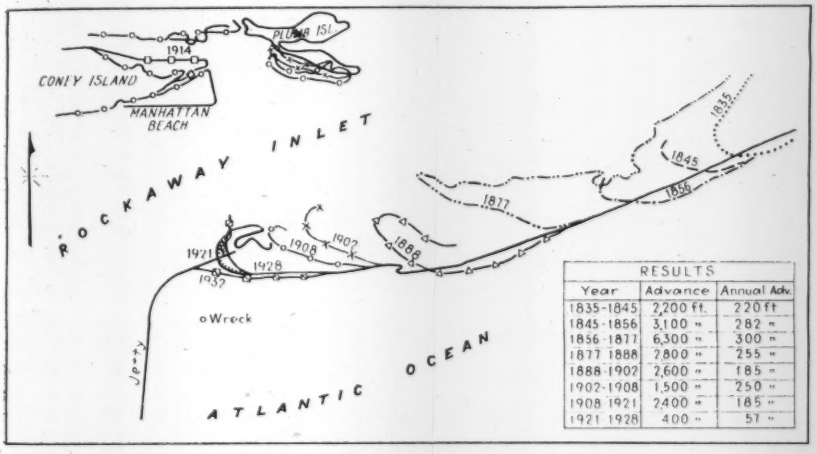


Fig. 4—Growth of Rockaway Point before construction of jetty.

By combining sand-content measurements with observations of longshore current velocities and depth of water at Long Branch, the curve *B* of Fig. 3 was obtained, showing more than 10 cu.yd. per foot of distance from the plunge point transported along the beach. Very much lower rates of sand movement were observed at Pensacola (curve *C*).

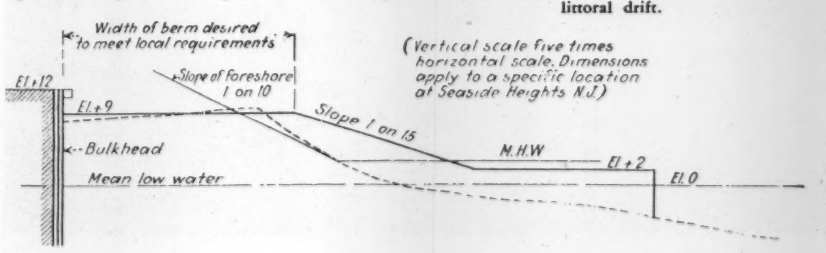
Direct evidence of the large amount of sand movement is furnished by the formation and growth of spits and points. A typical instance is represented by the map of changes at Rockaway Point (Fig. 4), where the extension of the point from 1835 to 1927 proceeded at an average rate of more than 2,000 ft. per decade. The curved rock jetty at the end of the point, whose construction was begun in May, 1931, with the purpose of impounding the sand that drifts westward along the south shore of Long Island and keeping it out of the entrance channel of New York harbor, accumulated nearly 300,000 cu. yd. from the time construction was begun to the fall of 1932, a period of a little more than a year, according to extensive soundings made by the board.

Sand movement at inlets

Special study was given by the board to current and sand movements at inlets, because of the large number of inlets through the New Jersey barrier beaches. Of 37 present or former inlets, twelve are now open. Most of them tend to shift in the direction of the littoral drift, and some require to be kept open by artificial aid. Manasquan Inlet, recently redredged after its closure by a storm, has been protected by heavy and long stone jetties.

The difference in the form of flood and ebb currents into entrances of inlets tends to cause the formation of crescent bars off inlets, extending in leeward directions. According to the board, the irregular action of these currents is reflected in the shore forms at inlet mouths, inward bent hooks at one or both points, occasional projection of the windward point beyond the leeward point, and the migration of inlets in leeward direction due to the building out of the windward point and erosion of the leeward point. The relation of the littoral drift to the current through the inlet (or harbor mouth) determines and modifies those forms in connection with wave action. Further, continued extension of the windward point of the inlet may form a long low beach that is easily breached in a storm. In this event a new inlet is usually created, and the original inlet tends to shoal up and close, after which the new inlet proceeds to travel in the direction of the littoral drift as did its predecessor.

Fig. 5—Suggested groin profile for normal beach conditions where there is much littoral drift.


Width of berm desired to meet local requirements
(Vertical scale five times horizontal scale. Dimensions apply to a specific location at Seaside Heights N.J.)
El +12
Slope of foreshore 1 on 10
El +9
Slope 1 on 15
Bulkhead
M.H.W
El +2
Mean low water
El 0

Beach protection by groins

Jetties or groins check the drift of sand along the shore and collect sand on the side from which the prevailing longshore current comes, while they allow the leeward beach to erode. The board holds that such structures should not be materially higher than the limit of uprush at ordinary high tide; that groins set at right angles to the shore line are preferable to those inclined either to windward or to leeward; and that groin spacing of 1½ to 4 times the length of the groin measured from the bulkhead or dune line is satisfactory. With a large volume of littoral drift, the longer spacing has proved successful, while with small volume the shorter spacing is desirable.

The longtitudinal groin profile recommended by the board is shown in Fig. 5. The desirable groin length is not specified, but the groin is to be carried so far, or to such depth "as a consideration of the local sand movement diagram indicates is the most economical and efficient."

Sand passing the groin should be caused to pass over the top above the mean-sea-level contour of the foreshore, and should not be allowed to pass around the end, where it may be lost in deeper water. Accordingly, groins should not be built too high, and in the case of a series of jetties the windward structures should be kept lower than is shown in Fig. 5, in order to pass enough sand to supply the leeward structures.

Where no natural supply of littoral drift is found, long and high jetties will convert the shore line into a series of bays, producing a shore of sawtooth outline and preventing the loss of existing beach material.

The present board is headed by Col. W. J. Barden, and includes Col. E. I. Brown, Col. E. J. Dent, Major G. R. Young, Gen. R. K. Hale (Massachusetts), Prof Thorndike Saville (North Carolina), and Victor Gelineau (New Jersey). Capt. L. H. Hewitt, Washington, is recorder of the board.

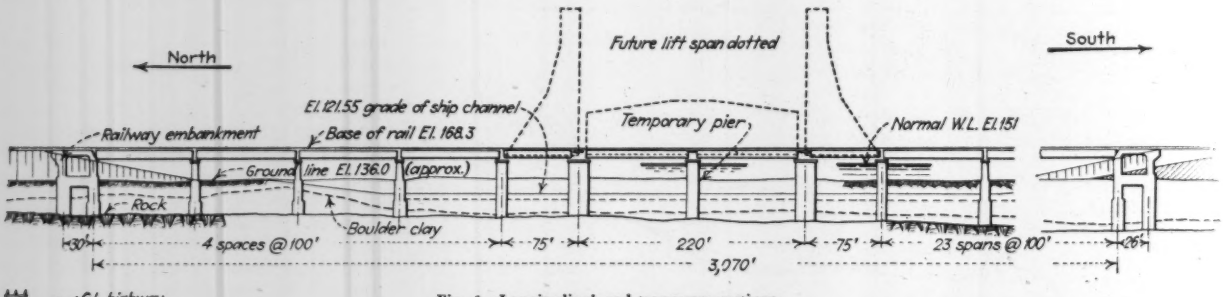
[A limited number of mimeographed copies of the board's report are still available. They may be obtained from Capt. L. H. Hewitt, recorder, Beach Erosion Board, Navy Building, Washington, D. C. Price 25c.—EDITOR.]

Rail and Road Bridges on Same Foundations

One of several structures required over new Beauharnois Canal in Quebec consists of two plate-girder bridges over 3,000 ft. long and supported on a single set of 34 concrete piers sunk to rock and sealed under pressure

THE COMBINED highway and railway bridge that will accommodate the tracks of the Canadian National Railway as well as the St. Louis-St. Timothee Highway is typical of the bridge structures required to cross the canal of the Beauharnois navigation and power project in Quebec. The canal, which is 15 miles long and eventually will be 3,300 ft. wide and 27 ft. deep (*ENR*, Dec. 11, 1930, p. 916), intersects three railway lines and numerous highways. Means had to be provided for these routes to cross the canal, and it was incumbent upon the Beauharnois Construction Co. to provide them. In the case of this particular bridge the necessary requirements of the Canadian government, the railway company, the Province of Quebec and the consulting engineers of the Beauharnois Power Co. had to be met. The railway and highway bridges are entirely distinct, each had to be designed for its own live load, with proper allowances for dead loads and impact in accordance with the railway and highway specifications respectively. Fig. 1 shows a longitudinal and a transverse section of the bridge. The entire construction was completed before water was allowed to flow into the canal, thereby enabling all operations to be completed from the surface of the original ground.

The most desirable type of bridge was found to be a series of plate-girder spans, with provision for future erection, under traffic, of two towers and a 200-ft. movable span for navigation. Prior to the installation of the lift span, temporary construction is employed consisting of two 100-ft. spans similar to those required on the remainder of the bridge and supported at the center of the navigation channel on a removable concrete pier. This pier is hollow down to the grade of the navigation channel, at which elevation it is joined to the footing by a horizontal asphalt joint. Also all reinforcing in the vicinity of this joint is on the inside face of the well. Thus, when it is desired to remove the pier prior to installation of the lift span, the reinforcing



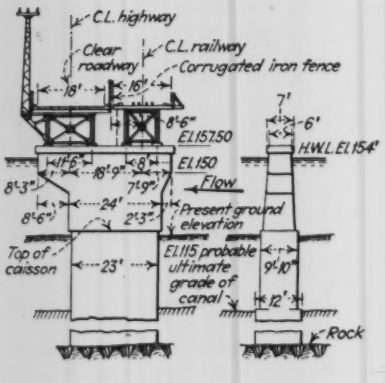
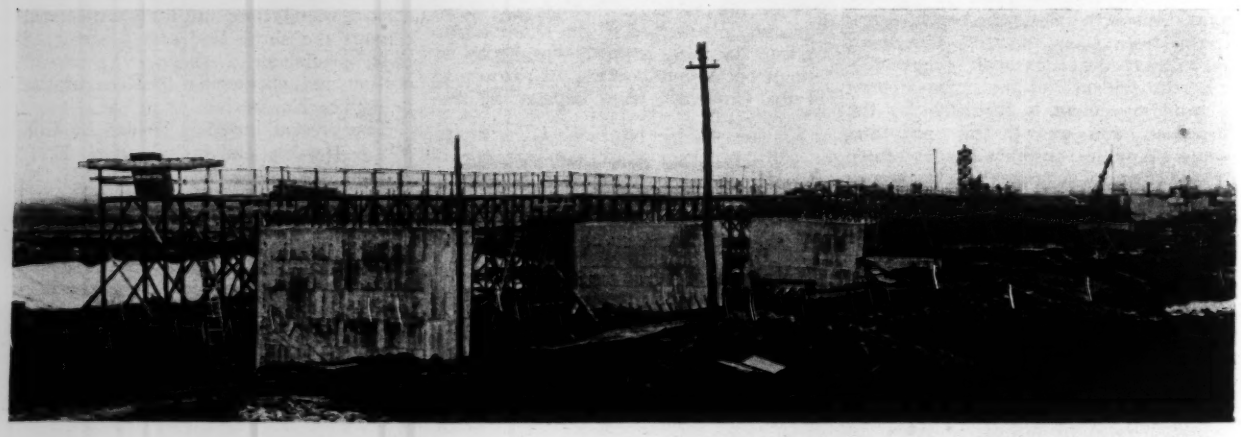


Fig. 1—Longitudinal and transverse sections of the combined railway and highway bridge over the 3,300-ft.-wide canal of the Beauharnois power and navigation project in Quebec.

Canadian government required provision for a movable span of 200-ft. clear opening, to be erected when navigation required it at some future time. The railway required a single-track structure designed for Cooper E-60 loading. The highway requirements were for an 18-ft. roadway designed for a live load of two 15-ton trucks or 100 lb. per sq.ft. As the superstructures for the

Fig. 2—Thirty-four concrete caissons forming the piers of the bridge were sunk from 36 to 57 ft. and sealed into the rock under pressure. Portable mixers dumped concrete into buckets in elevators that raised it to buggies on a runway parallel with the bridge. At present only a portion of the 3,300-ft. width of the canal is excavated so that most of the work was carried out on land.



steel can easily be exposed and burned loose, after which the hollow shell may be lifted and towed away on a barge.

Foundations

It was determined in the beginning to carry all foundations to bedrock through a marine deposit known as Ledo clay overlaying a glacial conglomerate called boulder clay. The Leda clay comprises the fine materials of the glacial drift and has a water content of more than 50 per cent. The boulder clay is more nearly the whole of the glacial deposit and also is water-bearing. Bedrock is standstone.

A total of 34 foundations was required, varying in depth from 36 to 57 ft. After a thorough study and the trial of a combination concrete-timber caisson, it was decided to use reinforced-concrete caissons of the shape and dimensions of the required finished piers, with an addition of 12 in. to breadth and width to provide for possible inaccuracy in sinking. The caissons were usually formed and concreted to a height of 10 ft. before the sinking operation was started, and then subsequent lifts were added as the sinking progressed. As much of the excavation as possible was done in the open, but when the inflow of water was too great to be handled by a 10-in. pump an air lock was installed and the work was completed under pressure. The cutting edge was made by tapering the bottom of the shell from the maximum thickness to the width of the flange of a 10-in. channel. The resistance to sinking due to side friction was 200 to 300 lb. per sq.ft. in the Leda clay and about 800 to 1,000 lb. per sq.ft. in the boulder clay. Average sinking was about 3 ft. per day in the boulder clay and 8 ft. per day in the Leda clay.

Considering the entire nature of the work, it was thought most economical to use small portable mixers and to feed them from stock piles of stone and sand laid down parallel to the center line of the bridge. Concrete was transported from the mixers to place by buggies along elevated runways. Bucket hoist towers were used to raise the concrete from the mixers to the level of the runways. Much of the construction was carried out during the winter season and, as the site was in a very exposed location, heating of the mixing water and aggregate was necessary. Three steam boilers were used for heating, and heavy tarpaulins provided protection for the concrete in the forms. The cement content was also a little in excess of that dictated by theoretical design. Besides being a protection against cold weather this excess cement also provided somewhat higher early strength and assured greater density for the concrete.

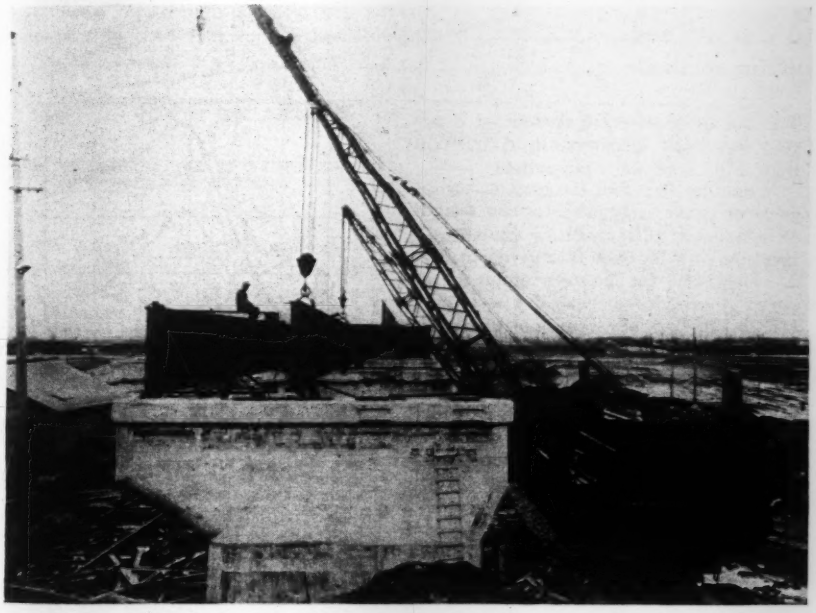


Fig. 3—Steel erection was carried out by means of locomotive cranes operating on a temporary track placed alongside the bridge.

Superstructure

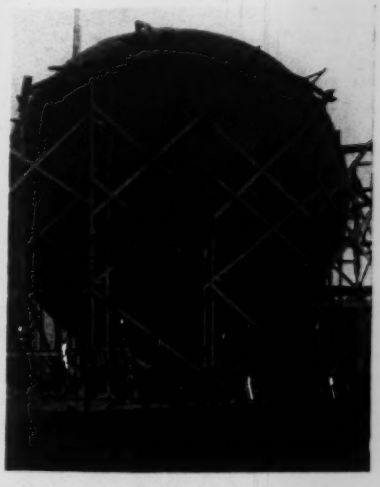
The superstructure erection was notable principally for the speed with which it was carried out. A temporary track was laid on the ground parallel to the bridge, as shown in Fig. 3, and the entire bridge of 31 railway spans and 31 highway spans was erected by locomotive cranes in 60 days, or at the rate of two spans per day.

One special feature of the superstructure is worthy of note. During the period of dredging operations in the canal it will be necessary to pass a dredge and various pieces of floating equipment through the bridge. Since the lift span probably will not be installed at that time, it was necessary to make provision for a temporary removable span. One of the short spans adjacent to the future lift span was chosen. It weighs 190 tons and can be handled by a 45x80-ft. scow that can be run under the span and raised by pumping out water ballast.

The power project is owned by the Beauharnois Power Corp., of which R. A. C. Henry is vice-president and general manager, with T. H. Hogg, W. S. Lee, A. S. Crane and the late F. B. Brown as consulting engineers. The construction of the project was carried out by the Beauharnois Construction Co., a wholly owned subsidiary under the direction of F. H. Cothran, vice-president, general manager and chief engineer, and the following staff: D. F. Noyes, general superintendent; M. V. Sauer, hydraulic engineer; B. K. Boulton, electrical engineer; and L. H. Burpee, bridge engineer. On the work herein described C. G. Kingsmill was resident engineer and A. R. Terwilliger superintendent of construction.

Welding a Spherical Tank 45 Ft. in Diameter

Spheres such as the one illustrated, which is used as a mixing tank for gas by the St. Louis Gas Co. at Shrewsbury, Mo., have previously been fabricated by riveting, using butt-strap joints. This tank was completely arc-welded. It has a diameter of 45 ft. and a rated capacity of 162,000 cu.ft. of gas at 50 lb. per sq.in. pressure. According to the Lincoln Electric Co., whose shielded-arc process of welding was used, there is a total of 1,256 lin.ft. of joint on the tank. Inasmuch as four beads were used in making a joint, a total of more than 5,000 ft. of welding was required. The tank was fabricated and erected by the Chicago Bridge & Iron Works.



Welded sphere for high-pressure gas storage and mixing.

Second of Four Articles on Design and Construction of Rolled-Earth Dams

Description of Field and Laboratory Methods

Air-void and dry-weight curves — Soil-plasticity needle determinations of moisture content and compaction—General field and laboratory methods

By R. R. Proctor

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CONSIDERING the sandy-clay soil discussed in the first article of this series (*ENR*, Aug. 31, p. 000) and charted here in Fig. 2, the graph, Fig. 3, shows the results obtained from compacting the soil by three methods, as discussed in connection with Fig. 2 of the first article. Curve *A* was obtained by actual field tests in which the soil was compacted to the fullest possible extent by a sheepsfoot roller similar to many that are in use. Curve *B* is identical with the dry-weight curve in Fig. 2. Curve *C* was obtained by the laboratory standard method of compaction, which will be fully described later. Sheepsfoot rollers have been designed and constructed to duplicate the results shown on this curve.

Fig. 1—Measurement of the plasticity-needle penetration resistance in a fill compacted for a test of sheepsfoot rollers. The uncompacted surface is removed to permit full penetration of the needle.

The peaks of the dry-weight curves of Fig. 3 occur at lower moisture contents as the peak dry weight increases. This is in accord with the theoretical discussion of soil compaction. The effect of increasing the weight of compaction equipment is clearly shown. The use of a moisture content of 8 per cent has been discussed in connection with Fig. 2 of the first article.

It may be seen that the heavier equipment of curve *C* produces a dry weight of 116 lb. at this moisture content, an increase of 8 lb. over that given in Fig. 2. However, the lighter equipment of curve *A* produces a peak dry weight of 117 lb. at 13.5 per cent moisture content, 1 lb. more than that secured by the heaviest equipment with 8 per cent moisture content, as shown in curve *C*. It is thus seen that proper moisture control with light equipment may give results superior to those obtained from very heavy equipment without proper moisture control.

The zero air-voids curve

The zero air-voids curve of Fig. 3 presents combinations of dry weights and moisture contents of this soil that are the conditions of complete saturation. The dry weight and specific gravity of the soil particles fix the volume of the soil solids. The remainder of the space is the voids, which become filled with water upon complete saturation. The percentage of voids in the soil corresponding to the various dry weights is shown along the zero air-voids curve. The ultimate capacity for water absorption in this soil, when compacted at various moisture contents and by the different methods, can be determined from Fig. 3 by noting the moisture content at the intersection of the zero air-voids curve and the dry weight of the compacted soil. It will be noted that none of the compaction methods are able to attain a condition of complete saturation in the compacted soil; this is attributed to the contained air previously mentioned. The condition is similar to that found in all soils, without exception, that have been experimentally compacted and in tests conducted of the compaction accomplished in the construction of dams.

It has now been shown that soils that are compacted at too low moisture contents, regardless of the care used in construction and of how hard they are at that time, may have a capacity for considerable more water in the voids, which causes them to become much softer when saturation occurs. The use of too light construction equipment and too little moisture in the soil may result in a dangerous condition if the dam should become fully saturated by percolating water.

Dry-weight curves

Fig. 4 shows the compacted dry-weight curves for several soils compacted by the same method. These soils varied in specific gravity from 2.68 to 2.76. The curves are plotted to show the dry weights that would have been obtained if they had been of the same

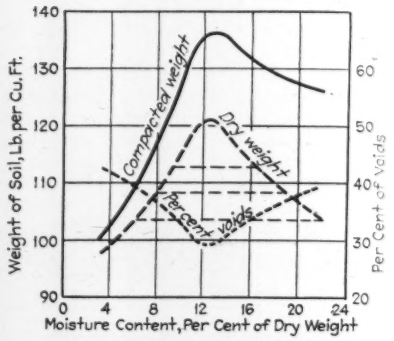

Weight of Soil, Lb. per Cu. Ft.
Per Cent of Voids
Compacted weight
Dry weight
Percent voids
Moisture Content, Per Cent of Dry Weight

Fig. 2—Graph showing the effect of moisture content on the compacted weight, dry weight and voids of a sandy-clay soil when compacted by a particular method.

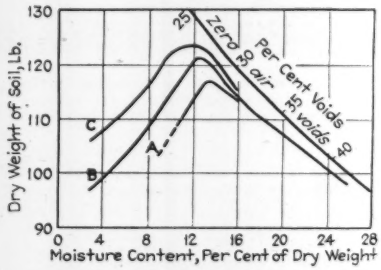


Fig. 3—Curves showing the effect of light, medium and heavy rollers on the dry weight, voids and saturated moisture content of a soil when compacted at various moisture contents.

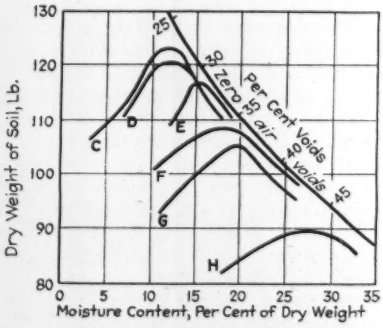


Fig. 4—Compacted dry weights, voids and saturated moisture contents for soils of different types, compacted by the same method at various moisture contents. The screen analyses of these soils are shown in Fig. 5.

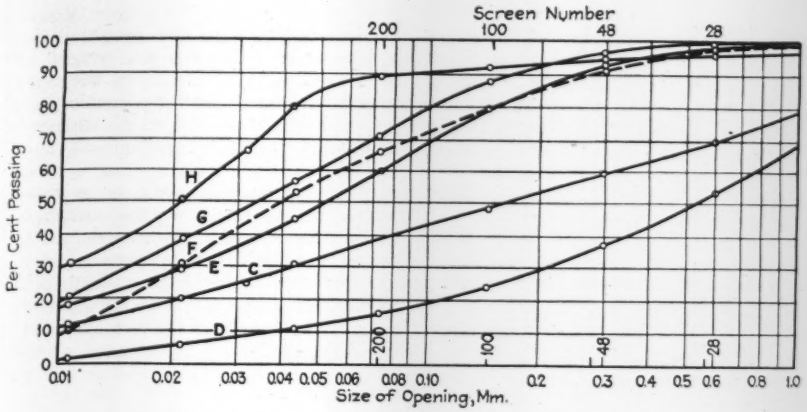


Fig. 5—Screen analyses of the soils used in preparation of Fig. 4.

specific gravity, in order properly to show the relation of the dry-weight curves to the zero air voids and per cent of voids curve. Curve *C* is from Fig. 3, curve *D* was obtained with a silty gravel, curves *E* and *G* were obtained with clayey soils, and curves *F* and *H* were obtained from California adobes. Fig. 5 shows the screen analyses of these soils. It will be noted that the peak of the compaction curve for the adobe of curve *H* is reached with a much greater moisture content and lower dry weight than the sandy clay of curve *C*. This is attributed to the larger proportion of fine particles in the soil, which require more water to lubricate their larger total surface area sufficiently for the compaction process to be most efficient. This results in a greater proportion of voids in the compacted soil, which offsets to a consisderable extent the increased watertightness caused by the necessity for percolating water to flow between the finer soil particles. A given amount of compacting produces a more stable soil from the sandy clay than from the adobe, although the adobe is entirely suitable and slightly more watertight.

Soil plasticity needle

The plasticity of compacted soils has been referred to as varying with the moisture content. An instrument known as the soil-plasticity needle was devised to measure soil plasticity in terms of the pressure required to force a rod with a slightly enlarged bearing surface, to penetrate the soil at a rate of about ½ in. per second. Rods of various sizes, usually referred to as needles, are used to keep the applied pressures between 5 and 100 lb. for convenience in hand operation. The pressures are expressed in pounds per square inch on the penerating area and are known as the plasticity-needle penetration resistances or the plasticity-needle readings. Fig. 6 shows the results obtained from the application of the plasticity needle to the compacted specimens prepared to derive curve *C*, Fig. 3. The pressures that have been given for a pencil to penetrate are based on the assumption that it has an area of 0.1 sq.in. It is interesting to note that Fig. 6 was obtained by use of needles that varied in size from 0.01 sq.in., with a pressure of 90 lb., to 1 sq.in., with a pressure of 8 lb. The complete use of the plasticity needle is best explained in connection with the discussion of the methods for applying the principles of soil compaction, which have been set forth, to the construction of dams.

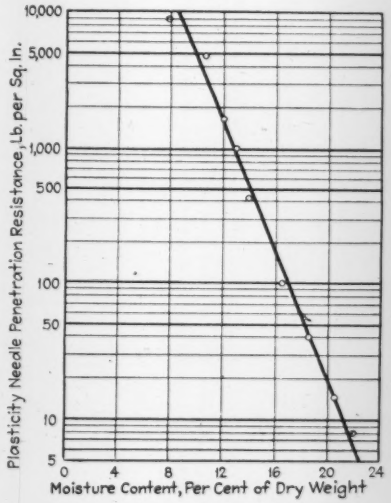


Fig. 6—Graph showing the plasticity-needle penetration resistances of a soil when compacted at various moisture contents by a particular method.

The method of compaction required to produce a given saturated plasticity in the soil used in preparation of Fig. 2 may now be approximately determined. It is assumed that a saturated plasticity-needle reading of not less than 300 lb. per sq.in. is desired. This soil would then have twice the penetration resistance required to permit loaded-truck travel when fully saturated. An inspection of Fig. 6 shows that a moisture content not in excess of 15 per cent is required. The dry weight of the compacted soil that contains this moisture when fully saturated is found to be 121 lb. (Fig. 3). Such a condition is not attainable with the equipment of curve *A*. A dry weight of 121 lb. is secured from curve *B* at a moisture range from 12 to 13 per cent. Curve *C* fulfills this condition from 9.7 to 14 per cent moisture contents. The proper limits should be from 12 to 14 per cent, which permits compacting the soil at a plasticity needle range of 1,500 to 500 lb. per sq.in., as shown in Fig. 6. This condition of saturated plasticity applies only near the surface of the compacted fill; at depths of a few feet below the surface the weight of the soil above causes consolidation, which increases the dry weight and makes the soil less plastic and more stable.

It has been pointed out in the discussion of Fig. 4 that the very fine adobe soil of curve *G* had no particular advantage of watertightness over the much coarser but well-graded sandy clay used for curve *C*. The usual opinion that the finer clays are much more watertight is accounted for in the shape of their dry-weight curves, which show a considerable range of moisture content without much change in the compacted dry weight. The quantity of water that will flow through a soil under a given pressure increases rapidly with a decrease in the dry weight from that of the peak of the dry-weight curve. For this reason, clayey soils can be compacted at a fairly large variation of moisture content without much effect on their watertightness.

The sandy clays, similar to that shown on curve *C*, do not permit such a wide variation; moisture variation from the peak of the curve similar to that permitted by the finer clays, with only a slight variation in dry weight and watertightness, causes a decrease in dry weight of as much as 8 per cent.

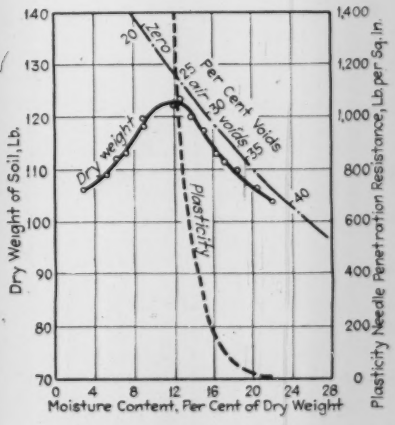


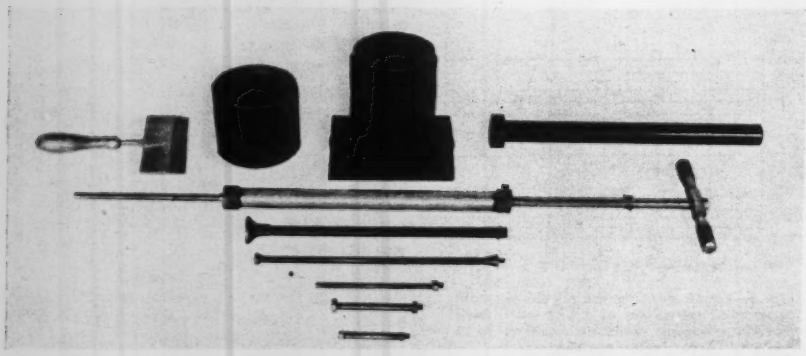
Fig. 7—Soil-characteristic curves for a sandy-clay soil showing dry weights, saturated moisture contents, voids and plasticity-needle penetration resistances when compacted by the standard laboratory method at the indicated moisture contents.

This increases the voids as much as 5 per cent, which permits a much more rapid flow of water and also, because of the larger amount of water that is absorbed, permits a considerable softening from saturation. The percolation rates that have been deermined for the soils shown in Fig. 4 do not indicate any important difference in watertightness when they are compacted to dry weights that are within 2 lb. of the peak of the dry-weight curve.

Soils suitable for dams

Any soil may be used in the construction of a dam if the velocity of flow is determined and found to be too slow to erode any of the soil particles, and the compacted and consolidated dry weight limits the softening from saturation, as determined by the plasticity needle, to that at which the soil is sufficiently stable for the particular dam. Many soils that have been

Fig. 8—The compaction cylinder, sleeve, 5½-lb. rammer, cutting tool and plasticity needle with points from 1/20 to 1¼ sq.in. in area.



thought very undesirable for use in a dam have been found to be quite suitable for this use when placed under careful engineering supervision, using the principles that have been set forth. The engineer is enabled to study the characteristics of the soils that are available by actual test before the dam is designed, and to plan their disposition in the structure. The proper type of compacting equipment and the method of its use may be determined at the same time. Methods and equipment for obtaining a precise control of the moistening and compacting of the soils will be discussed next. A method for determining the dry weight of the compacted soil after it is placed in the dam will be discussed, and a procedure will be described for testing this soil, at the dry weight of placing, for softening or consolidation and watertightness, under pressures that are fixed by its position in the finished structure.

Laboratory methods

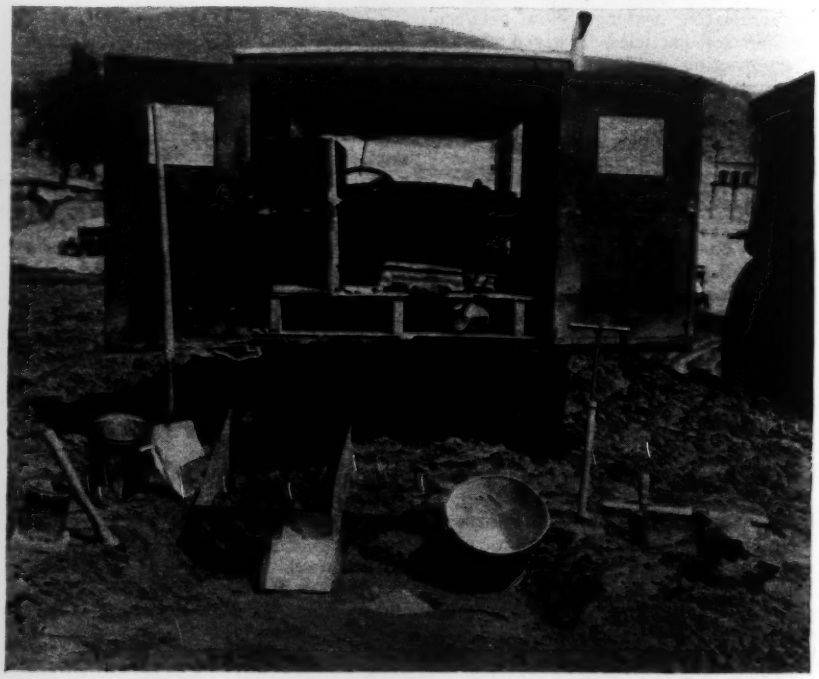
Compacted specimens of a soil that are prepared at different moisture contents have been shown to vary in dry weight and plasticity. Fig. 7 shows these values plotted on one diagram, known as the soil-characteristic curves. The curves are those of *C*, Fig. 3, and of Fig. 6, representing the sandy clay soil previously discussed when compacted in the standard laboratory manner. This is accomplished by passing the soil through a ¼-in. mesh screen and compacting it at various moisture contents in a cylindrical container about 4 in. in diameter and 5 in. deep, which has a removable baseplate and a loose collar at its top.

The soil is compacted in three layers of sufficient depth to permit removing the top collar and cutting the compacted soil at the top to the exact cylinder dimension. Each layer is subjected to 25 firm 12-in. strokes, using a rammer of 5½-lb. weight with a striking area 2 in. in diameter. The compacted weight of soil per cubic foot is then calculated. The moisture content is determined by drying a small sample at 250 deg. F. until no further loss in weight occurs; it is expressed as the ratio of the loss in weight by evaporation to the oven-dried weig[ht] of the sample. The dry weight is d[e]termined by deducting the weight [of] the contained moisture from the co[m]pacted weight of soil per cubic fo[ot]. It is the weight of soil solids contain[ed] in a cubic foot of compacted soil.

The plasticity-needle reading is take[n] of each compacted specimen at thr[ee] points immediately after the surface [is] cut to the cylinder dimensions. Th[e] operator judges the average penetr[a]tion pressure required for a depth of [¼] in. and takes the mean of the penetra[-]tions as the reading for the specimen. The compacted-soil specimens should vary in needle readings from 100 t[o] 3,000 lb. per sq.in., with sufficient in[-]termediate values to determine properly the dry weight and plasticity-needle curves. A precise mechanical method could be easily devised to compact the soils in the laboratory, but it could not be conveniently used in the field. It is necessary to make frequent compaction and plasticity-needle tests in the field. The methods that have been outlined are of sufficient accuracy for use in the laboratory, and the equipment is sufficiently portable to allow quick and accurate field tests to be made wherever desired.

The specific gravity of the soil particles is determined in order to establish the position of the zero air-voids curve. The method of obtaining this is important, due to its effect on the calculations of the quantity of water that the compacted soil may absorb. Air is trapped between the smaller soil particles and is difficult to remove. This is part of the contained air not removed

Fig. 9—Equipment for measuring the dry weight of soil in place.



by compaction processes. A weighed sample of soil that has been oven-dried for determining the moisture content is placed in a known volume of water. The volume of the mixture, after thorough shaking, is often used to determine the volume of the soil particles. The application of a partial vacuum of about 4 cm. absolute pressure at this time will produce a surprising result. Air leaves the soil very rapidly and, because of the low pressure with consequent enlarged bubbles, it appears as if a volume of air about equal to the soil was leaving. The application of this air exhaustion process is required for about a half hour. A specific gravity of soil particles of 2.68, determined by thorough shaking in water, was increased to 2.74 by using the air-exhaustion process. This error reduces the moisture content for saturation (Fig. 7) at the peak of the dry-weight curve from 14.8 to 13.6 per cent Measurements of the dry weight of saturated soils in place often indicate the presence of water in excess of the calculated voids, if the specific gravity of soil particles is determined in the usual manner.

Field and laboratory use of needle

The plasticity needle, being hand-operated, is adapted for use in the field or laboratory. It is used in the laboratory to prepare moisture-plasticity curves of the various soils, for use in the field. It is usually possible to determine the moisture content of a soil, for which a plasticity-needle penetration-resistance curve is available, within a few minutes by compacting the soil in the easily portable compaction cylinder similar to that used in the laboratory, and taking the average of three penetration readings. The moisture content of the soil is then obtained from the moisture-plasticity curve, similar to Fig. 7, which has been prepared in the laboratory for that particular soil. The readings in most cases may be taken much closer than the variation shown on the curve for 1 per cent moisture. Fig. 7 shows a plasticity-needle reading of 1,400 lb. per sq.in. for 12 per cent and 850 lb. per sq.in. for 13 per cent moistures. The use of a needle of 1/20-sq.in. area makes the pressures required 70 and 42.5 lb., respectively.

Readings are readily taken to the nearest 5-lb. pressure. The indicated range in pressure for 1 per cent moisture change is 27.5 lb. This indicates an accuracy of about 0.2 per cent in moisture content, much more accurate than the 1 per cent allowable error. When used in this manner the plasticity needle enables the inspector to make a frequent check of the moisture content of the soil as it is placed on the dam. This is absolutely essential to the proper control of the compaction process.

The completeness of compaction may be closely determined with the plasticity needle. This is accomplished by determining the reading in the compacted soil on the dam. Some of the soil is then removed and compacted in the cylinder. The needle readings are taken in the cylinder and should agree with those in the dam if the soil is sufficiently compacted. This method is adapted for frequent use and should be controlled by direct measurements of the dry weight of the soil in place. The principle of the plasticity needle may be used to measure the plasticity at various points in constructed dams, if the soil is known to be saturated, by determining the penetration resistance in auger holes or shafts. Its use in percolation and consolidation tests will be described in their connection.

Measurement of dry weight in place

It is necessary to determine the dry weight of the soil in place after compaction, definitely to check the effectiveness of the soil-compacting process. The surface soil is removed from a small area to such a depth that no uncompacted soil remains. A hole about 8 in. in diameter and 1 ft. in depth is dug, and the removed soil is weighed. The volume of the hole is determined by filling it with a fine dry sand, the weight per cubic foot of which is found by pouring it into a container of known capacity, of about the same dimensions as the hole. The weight of sand used determines the volume of the hole. No attempt is made to pack this sand; it is carefully calibrated as to its weight per cubic foot when poured in loose. It is necessary to level the top of the sand carefully to the exact position from which the soil has been removed. The soil removed is sampled for oven-drying to determine the moisture content. The weight per cubic foot of the compacted soil in place is calculated, and the dry weight is determined by deducting the weight of the contained moisture from this figure.

This method enables the dry weight to be determined within about ½ lb. per cubic foot. Some of the soil removed in making this test may be compacted in the compaction cylinder, the weight per cubic foot obtained, and in this way compared with the compacted weight found in the dam. The two should be equal, if the moisture content is not allowed to change while the test is being made. It is necessary to perform this test quickly, and in the field, particularly in hot dry climates, to prevent loss of water by evaporation. Figs. 8 and 9 show the equipment and methods used to determine the dry weight and plasticity of soil after compaction.

Placing soil in test equipment

The soil-characteristic curves of this soil, similar to Fig. 7, may now be obtained in the laboratory and a comparison made with the dry weight in place. This precisely determines the effectiveness of the compacting process. By compacting the soil removed in any desired test apparatus at the correct moisture, as shown by the dry-weight curve to give the dry weight in place, the soil is ready for any test under the exact conditions at which it was placed in the dam. The dry-weight curve can also be used to determine the moisture content required in order to place the soil at any other dry weight for any desired test. It is necessary to use the same weight of rammer as used in preparation of the compaction curve and the same number of blows on a square inch of surface as used in the compaction cylinder. The thickness of layers must be kept the same.

Specifications for Steel for Fusion Welding

STEEL suitable for fusion-welding may be obtained under any one of 23 current specifications of the American Society for Testing Materials, according to the society's steel committee. The grades defined by these specifications will usually have a carbon content less than 0.35 per cent, within which limit the usual commercial welding practice is adequate; other steels can be fusion-welded by proper procedure and the use of suitable fluxes and filler metal. The designation numbers and titles of the 23 specifications, as listed by the committee at the society's recent annual meeting at Chicago, are as follows:

A7-29 —structural steel for bridges.
A9-29 —structural steel for buildings.
A140-32T —structural medium steel.
A113-29 —structural steel for locomotives and cars.
A12-21, A131-31T —structural steel for ships.
A30-24 —boiler and firebox steel for locomotives.
A70-27 —boiler and firebox steel for stationary service.
A114-29T —marine-boiler steel plates.
A78-30 —steel plates of structural quality for forge-welding.
A89-30 —steel plates of flange quality for forge-welding.
A89-32T —steel plates of flange and firebox qualities for forge-welding.
A129-30T —open-hearth iron plates of flange quality.
A83-30, A83-32T lap-welded and seamless steel and lap welded iron boiler tubes.
A105-28 —forged or rolled steel-pipe flanges for high-temperature service (classes A and B steel only).
A106-29 — lap-welded and seamless steel pipe for high-temperature service.
A53-30 —welded and seamless steel pipe (with restrictions as to carbon content).
A134-32T, A139-32T —Electric-fusion-welded steel pipe.
A135-32T —Electric-resistance-welded steel pipe.
A120-32T —black and hot dipped zinc-coated welded and seamless steel pipe for ordinary uses.
A82-27 —cold-drawn steel wire for concrete reinforcement.

In this list the first number of the designation is the serial number, while the number following the dash denotes the year of adoption. The final letter T denotes a tentative specification; all others are "standard."

Text of Code for Engineers in Construction Industry

Executive committee of American Society of Civil Engineers approves code for submission to National Recovery Administration as a supplemental code under the master code for the construction industry

A CODE of fair competition for the engineering profession, in so far as its practice is a function of the construction industry, was approved by the executive committee of the American Society of Civil Engineers on Aug. 25 for submission to the National Recovery Administration as a supplemental code under the master code for the construction industry. The code now goes to the code committee of the Construction League of the United States for coordination with the master code and the supplemental codes already submitted to the NRA and then will be scheduled for a public hearing before a deputy administrator of the NRA. Public hearings on the master code and upon the architects, general contractors and other codes for the industry began on Sept. 6.

The engineers' code was prepared under the direction of the American Society of Civil Engineers, that organization being the principal national engineering society functioning as a part of the construction industry. In its preparation, however, representatives of mechanical, electrical and other engineering groups whose work is wholly or in part in general construction were consulted, as were representatives of special groups and of national and local professional societies. Reports of the meeting at which preliminary drafts of the code were considered were published in *ENR*, Aug. 10, p. 180, and Aug. 24, p. 238. Carlton Proctor, consulting engineer, New York, is chairman of the society's code committee.

In the form as now submitted to NRA the code makes no attempt to set minimum fees for professional engineering services. Such minimum fees were set forth in a preliminary draft that was circulated to interested organizations and regional groups, but such divergent views developed as to make agreement on any specific statement of fees for various types of engineering impossible.

The text of the code for the professional engineer's division of the construction industry as submitted to the NRA follows:

Preamble

The American Society of Civil Engineers, organized in 1852, a national association representing the Profession of Civil Engineering, pursuant to the intention of the Engineering Profession, in so far as the practice of the engineering profession is a function of the Construction Industry, to cooperate with the President of the United States in effectuating Title No. 1 of the National Industrial Recovery Act, during the period of the emergency, hereby recommends and submits for approval pursuant to Section 3 of said Title, the following Code of Fair Competition covering relations between professional engineers, clients or employers, employees and others in respect to all construction work; this Code having been subscribed to by duly authorized representatives of the following professional engineering organizations:

Blank for organization names

In submitting this Code for the approval of the President and in tendering their agencies for the enforcement thereof, the American Society of Civil Engineers and the other organizations subscribing above declare:

a. That they are truly representative of the engineering profession in so far as it is functional to the Construction Industry;

b. That they impose no inequitable restrictions on admission to their membership;

c. That this Code will not permit monopolies or tend toward excessive fees or wages, but will tend towards fair fees and wages and the eradication of unethical and unfair practices such as "bid-shopping" and enforced unfair competition between engineers, and towards the establishment of better professional standards of practice;

d. That this Code is intended to eliminate unfair competitive practice and to advance the public interest and engineering standards, and to improve standards of working conditions and living, and effectuate the spirit of the policies set forth in the National Industrial Recovery Act.

Article I—The General Code

The Code of Fair Competition for the Construction Industry, as approved by the President of the United States, is adopted and made a part hereof and shall be attached hereto, and any provisions of this Code of Fair Competition for Professional Engineers which may be inconsistent therewith shall yield thereto.

Article II—Definitions and Functions

Professional Engineer—In the meaning and application of this Code a professional engineer shall be considered to be and include an individual, partnership or engineering corporation legally operating in responsible charge of the design or supervision of construction work;

or a person in the employ of the same and who is registered or licensed in accordance with the provisions of law to practice engineering, or any subdivision thereof, within any State or Territory of the United States;

or any person admitted to, or eligible by reason of technical training for admission to membership in any national, state or regional professional engineering organization, in grades which require, as a constitutional provision, active practice as an engineer for not less than seven years and responsible charge of engineering work for not less than one year; active practice and responsible charge of engineering when functional to the construction industry to be determined as defined in the Constitution of the American Society of Civil Engineers.

Where used hereinafter the word "engineer" shall be construed as an abbreviation of the term "professional engineer" as herein defined.

In the meaning and application of this Code the functions of an engineer shall include the economics of, and the use and design of, materials of construction and the determination of their physical qualities; supervision of the construction of engineering structures; the investigation of the laws, phenomena, and forces of Nature; when any of the same are involved or employed in connection with fixed works for any or all of the following divisions or subjects; irrigation, drainage, water power, water supply, flood control, inland waterways, harbors, municipal improvements, railroads, highways, tunnels, airports and airways, purification of water, sewerage, refuse disposal, foundations or sub-structures, framed or homogeneous structures, buildings and bridges; they shall include the investigation of, the design of, and the selection of, the force-resisting and load supporting members of structures; such as foundations, walls, columns, beams, girders, slabs, trusses, and similar members; and the investigation of, design of, and selection of mechanical, electrical, or sanitary component parts of structures; where such investigation, design and selection requires a knowledge of engineering laws, formulae and practice, a knowledge of the physical properties of the materials used, and a knowledge of the methods used in their installation; and the supervision and coordination of the design and execution thereof. Anyone performing any of these functions shall be considered an engineer subject to all of the conditions of qualification and experience in the above definition of a professional engineer, and subject to all conditions and regulations of this Code.

Where a Professional Engineer registration or license law is in effect, any registered or licensed professional engineer shall be entitled to practice as an engineer but shall not be relieved by that fact from any of the provisions of this Code.

Engineering Assistant—In the meaning and application of this Code an engineering assistant shall be any person who, not registered or licensed by any state, or territory to practice engineering as a profession and not eligible for membership as hereinbefore defined in any professional engineering organization providing for membership as hereinbefore described, is employed to render technical or other services of a sub-professional nature under the direction of an engineer.

Client—A client shall be an individual, firm, corporation, or governmental agency, who engages the services of an engineer on a fee basis.

Employer—An employer shall be any individual, firm, corporation, or governmental agency, who engages the services of an engineer or an engineering assistant on a salary or wage basis.

Contractor—A contractor shall be any individual, firm, corporation, or agency con-

tracting to perform the work called for by the engineer's plans and specifications.

Article III—Required Provisions

Engineering assistants shall have the right to organize and to deal collectively, through an agency or organization of their own choosing, with an employer.

No engineering assistant shall be required to join or affiliate with any agency or organization, nor shall he be compelled to deal with an employer through such channels. Neither shall he be restrained from voluntary affiliation with, or use of, any agency or organization.

Each engineering assistant shall recognize the contractual relations of employer and employee and failure to render in full the services agreed upon shall be considered as a violation of this Code.

In filing this Code, it is agreed that, as a condition of approval, the President may impose such conditions, modifications, or additions, exceptions or exemptions as he may deem necessary or expedient in the public interest to effectuate the policy established in Title I of the National Industrial Recovery Act.

a. Minimum Wages—No engineer or engineering assistant, employed on a salary or wage basis, shall be paid less than the minimum rates which are established regionally or locally by mutual agreements between truly representative groups of employers and employees or as established or approved by the National Control Committee, as defined in Article VII, through its subordinate regional, state or local committees, and approved by the President, as provided by Section 7 (b) of the National Industrial Recovery Act. Where such rates are not so established, the minimum rates of wages shall be not less than those required by Article 3—"Minimum Wages of the 'Code of Fair Competition for the Construction Industry.'"

b. Maximum Hours—Maximum working hours for engineering assistants shall be in accordance with Article 4—"Maximum Hours of the 'Code of Fair Competition for the Construction Industry.'"

c. Age Limit—Engineers shall not employ any one less than sixteen years of age, except that persons between fourteen and sixteen may be employed for not to exceed three hours per day between 7 a.m. and 7 p.m. on such work as will not interfere with hours of day school.

d. Stabilization of Employment—Engineers shall administer their functions so as to provide the maximum practicable continuity of employment to those in their employ.

Article IV—Regulations Governing Relations Between Engineers and Their Clients or Employers

Where the engineer's services involve a fee of $1,000 or more, his relations with, and responsibilities to his client shall be evidenced by duly executed written agreements. Neither of the contracting parties shall assume any of the duties or responsibilities hereinafter defined as obligatory on the other nor may one of the contracting parties receive any part of the pay or profit hereinafter defined as belonging to the other.

An engineer shall at all times abide by the "Code of Ethics" adopted by the American Society of Civil Engineers September 2, 1914, and by the "Code of Practice of the American Society of Civil Engineers," adopted January 18, 1927, which are appended hereto, and these codes of ethics and practice are hereby made a part of this Code of Fair Competition, and subject to the same conditions of enforcement as if herein written in full. Violation of this "Code of Fair Competition for Professional Engineers" shall justify cancellation of relations by a client, dismissal by an employer or discipline by the National Control Committee and/or prosecution at law under the provision of the National Industrial Recovery Act.

An engineer shall not:

a. Acquire, own or otherwise benefit by the purchase, sale or ownership in any real estate or business interest which may be affected by any work for which he shares responsibility, except with full knowledge and consent of his employer.

b. Own stock in, or have other interest in, or in any way benefit from the business of a contractor employed on any work for which the engineer shares responsibility, except with the full knowledge and consent of his employer.

c. Accept any pay or commission, except as clearly stipulated in his contract or terms of employment, for the use of any materials, patented device, appliance, tool or method employed on the work.

d. Accept any fee or gratuity for engineering or other services rendered to any contractor or sub-contractor engaged on the work for which the engineer is engaged as the client's or employer's representative, or accept compensation, financial or otherwise for services in connection with such project, from any person other than his client or employer, except with the full knowledge and consent of his employer. Nothing herein shall be construed to operate against the prevailing and good practice by contractors and sub-contractors of engaging engineers, other than the engineer of record for the work, to render engineering services to them in connection with their engagement as contractors or sub-contractors.

e. Specify, direct, invite or accept engineering designs, studies or sketches from a contractor, sub-contractor or supplier of materials, interested in the work or in bidding on any element of the work, where such are services herein defined, or defined in his agreement with his client or employer, as being the responsibility and duty of the engineer. This does not debar the customary shop and working drawings, made by contractors for the work to be executed by them, nor the use of technical trade information issued by producers for the information of engineers.

f. Give any rebate, discount, bonus, fee or commission in order to reduce his fee, or to influence or procure employment.

Article V—Unfair Practices

To maintain fair minimum salaries and wages for engineers and engineering assistants the National Control Committee through its subordinate regional, state or local committees, shall, within four months after the effective date of this Code, establish schedules of fair minimum rates for all types of engineering services functional to the Construction Industry. In arriving at these schedules the National Control Committee shall endeavor to prescribe rates equivalent to the average rates which obtained in each region at the beginning of the year 1929.

To assure fair competition and prevent rendering of services below cost of production, plus overhead, insurance and incidental expenses, plus a reasonable profit, and to insure fair basis for the determination of cost-plus-fee terms of employment, the National Control Committee shall develop, with the cooperation of its subordinate regional, state and local sub-committees, standards of cost accounting with uniform methods of determining overhead, inclusive of principal's time and other chargeable items.

To maintain fair minimum rates of charge for the various branches of engineering practice functional to the construction industry and to avoid price cutting among engineers in private practice, but without any attempt at price-fixing, the National Control Committee through its subordinate regional, state, or local committees shall establish schedules of fair minimum charges, where practicable, for all types of engineering services functional to the Construction Industry. The recognition of such minimum schedules shall in no way operate against any engineer whose training, experience, reputation or specialized practice, justifies a higher schedule of charges.

In the operation of this Code, before the establishment of engineering fees as above described, no engineer shall charge for his services an amount less than his costs, including overhead and incidental expenses.

In order to eliminate unethical and unfair competitive practices that violate sound public policy and proper professional procedure:

a. An engineer shall not enter into fee, salary or wage competitive bidding with other engineers for a professional engagement.

b. An engineer shall not offer or provide free or contingent engineering services or free cost estimates, in competition with any other engineer whose services have been retained for the work.

c. An engineer employed in a salaried position on full time basis shall not solicit outside employment in competition with other engineers, nor authorize the use of his name for the solicitation of outside work. He may serve in a consulting or advisory capacity with the consent of his employer.

d. No person shall perform or undertake to furnish or be responsible for engineering services unless he is qualified by education, experience and organization and as herein defined.

The engineer should recognize and accept professional responsibility for the correctness, accuracy and safety of his design and for the completeness of information given to the contractor. He should not require the contractor to be responsible for any work not called for and not indicated by his plans and specifications, and should not require that the work be acceptable to the engineer except in conformity with stipulated requirements of the plans and specifications. Where necessary, the engineer should obtain adequate and sufficient subsoil data and subsoil tests and he should supply such information to the bidders. He should stipulate fair and equitable liability and damage insurance, and bonus, damage and indemnity provisions, where any or all of same are required.

The engineer shall observe the rules of fairness in making known all requirements for the work for which he is responsible.

Arbitration according to the procedure of the American Arbitration Association

shall be accepted as the approved method for adjudication of disputes, after decision by the engineer, and precedent to action at law.

Contractors and others furnishing materials shall not include engineering designs or engineering services with the furnishing of materials except as hereinbefore provided in Article IV, e, and then only when making a separate and distinct charge for the same to be paid by the owner, said charge to be not less than the usual or prescribed professional charge made by engineers for such engineering designs or other engineering services.

The engineer shall definitely establish in his design and specifications, the amounts of tolerance which will be permissible, and shall include definite provisions for additional installations, replacements, etc., if such tolerances are exceeded.

The engineer shall state clearly the time requirements of the various elements of the work or shall require the contractor to state them at the time of bidding.

The engineer shall not submit his design drawings and specifications for contractor's bid until he has developed adequate preliminary information and essential pertinent data. He shall provide the contractor with opportunity to satisfy himself as to the adequacy of the engineering information given and the practicability of the type and method of installation shown on the engineer's design and covered in his specifications. Adequate information should be issued to all bidders alike and the engineer should require the successful contractor to recognize and accept his full responsibility for the successful and safe prosecution and completion of the work in accordance with the contract documents. The engineer shall permit the contractor to submit, for the engineer's consideration, plans and details showing the contractor's proposed methods of installation, plant layout, and erection of temporary structures, and require that the engineer's consent be received by the contractor before such methods are adopted. The engineer shall require that if there be any existing hazards for which the contractor is unwilling to accept responsibility, such exceptions be evidenced by the contractor prior to the signing of his contract.

The engineer, where so engaged, shall provide adequate and sufficient field supervision and inspection of the work and shall at all times be ready to accept or reject any part of the work as the installation proceeds.

Article VI—Regulations Governing the Engineer

Recognizing the inherent differences in customs and procedures between the various branches of engineering involved in the general field of construction and that in any branch of engineering, customs and procedures differ depending upon the magnitude and complexity of a project and upon the experience and record of accomplishments of different engineers, and that some engineers are especially expert in highly specialized fields of engineering, this Article is necessarily a generalized statement of the duties to be undertaken and performed by the engineer. It is good practice that there shall be engaged engineers skilled in the specialized fields of engineering. This article does not cover detailed items of service incident to highly specialized fields of engineering, or to preliminary investigations or reports as to the feasibility of projects, but is a statement of minimum services to be performed by the engineer, the responsibilities for which may not be delegated by him except that this shall not prevent the employment of special services for surveys, subsoil investigations, laboratory analyses and tests, and similar services under the direction of the engineer as a separate account.

A. Investigations

a. Investigations, surveys, and collection of all necessary or essential data, assuring the accuracy and completeness of such data in so far as it controls the type of design, method of installation, stability of structure, or completeness or fairness of the bids on the finished work.

b. Studies, preliminary design and, where necessary or desirable, comparative cost estimates of same, in order to determine the ultimate design which will for safety and permanence best satisfy the requirements for feasibility of construction and economy.

c. Where necessary or desirable a report setting forth recommendations with such supporting statements, data and such drawings as are necessary for a clear understanding of the recommendations and the reasons therefor.

B. Designs, Contract Drawings and Specifications

a. Complete design of the work including all necessary design and contract drawings showing design details for the complete construction and/or installation of the work covered.

b. Complete specifications describing all elements of the work covered, particularly such elements as are not clearly or sufficiently detailed in the drawings, such specifications to outline methods called for as being acceptable to the engineer.

c. Invitation to bidders containing information sufficient to enable an experienced contractor to make a complete and fair bid covering the work.

C. Advisory Supervision of Construction

a. General supervision and coordination of the installation of the work.

b. Estimates of the value of work installed for partial and final payments to contractors when necessary or advisable.

c. Survey, record drawings, and certification as to the completion of contractor's work.

D. Detailed Resident Supervision of Construction

a. Resident supervision and detailed inspection of the work.

b. Field and/or shop inspection and tests of materials and equipment.

To effectuate the declared policy of the National Industrial Recovery Act, "to eliminate unfair competitive practices, and to rehabilitate industry," the engineer's procedure for the selection of a contractor by competitive bidding shall be governed by the following basic principles.

Fair competition shall include consideration of capability, experience, honesty, financial stability, price, and time.

The form of contract affects bidding; the following forms of contract, procedure, whether for entire projects or for any segregated compound part thereof, are recognized as proper; (1) lump sum; (2) guaranteed outside price; (3) cost of work plus a fee; (4) unit prices.

The engineer should limit the bidding to contractors who have properly prequalified as to reputation, experience and responsibility. He shall not recommend the award of the work unless the contractor can demonstrate to the awarding authorities that he is competent, technically and financially. A contract bond when required, shall not be held to reinforce or enhance a bidder's credit, stability or capacity, but shall be considered only as a protection against business accidents. Any bid may be accepted at the price originally submitted, except as otherwise covered by law.

The engineer shall not sanction or permit the payment of any fees, bonuses, or other forms of payment by any bidder for services rendered in connection with securing an award, nor the disclosure by any contractor of any bid to a competitor or otherwise to induce secondary bidding, nor to engage in the unfair practice known as "bid peddling."

The engineer shall require that every rebate, refund, allowance, discount, commission, or service privilege in whatever form, be extended by a vender to every purchaser under like terms and conditions.

To secure fair competitions as defined hereinbefore, no product or service shall be obtained below cost.

When practicable, bids shall be accepted within 20 days from bid date and quotations thereon by suppliers of material shall be held subject to acceptance within 30 days of such bid date.

All sales by suppliers of material to a contractor, except for cash, shall be stopped after 60 days credit, unless through no fault of the contractor, payments to him have not been made in accordance with his contract.

Article VII—Administration Provided for the Code

Amendments—Amendments or revisions to this Code may be proposed by any truly representative professional engineering organization providing for membership as hereinbefore described, acting through the National Control Committee hereinafter defined.

National Control Committee—To effectuate the purposes of this Code and provide for administration control within the engineering profession in so far as it is a function of the construction industry, a National Control Committee shall be established composed of four engineers appointed by the American Society of Civil Engineers, and one engineer appointed by each of the national professional engineering organizations providing constitutional provisions for membership as hereinbefore defined in Article II, and which are indicated in the first paragraph of the Preamble of this Code as having subscribed to this Code, and two engineers at large to be selected by the before mentioned members to represent the engineers who have no national professional engineering society affiliation.

This control committee shall have full authority to make all needful rules and regulations for the administration and enforcement of the provisions of this Code. This control committee shall have full authority to establish such sub-committees and such subordinate local, state and regional committees and to prescribe such duties, rules and regulations as are deemed necessary to carry out the purpose of this Code and of the National Industrial Recovery Act.

In the establishment of each such state committee (or where there is no state committee, in each regional committee), there shall be one representative, for each

state, from the recognized existing or hereafter created state professional society, in which membership is contingent upon legal admission to the practice of engineering within that state. Such representative shall be designated by such recognized state society.

The National Control Committee shall coordinate its acts with the administrative agency established under the Code of Fair Competition for the Construction Industry.

Administration Expense—All engineers in so far as their practice is a function of the construction industry and as defined in this Code shall bear their proportionate, share of the expense of administration of this Code under such rules and regulations as may be approved by the President under Section 10 (a) of Title I of the National Industrial Recovery Act.

Effective Date—This Code shall be effective when approved by the President of the United States and shall be applicable only to professional engineering services functional to the Construction Industry undertaken after such approval date.

Coast and Geodetic Survey Work Under the National Recovery Act

Funds allotted by the Public Works Board make it possible for the Survey to continue needed control lines and to bring old coast charts up to date

By Captain R. S. Patton,
Director, U. S. Coast and Geodetic Survey, Washington, D. C.

ALLOTMENT of $2,600,000 to the Coast and Geodetic Survey under the National Industrial Recovery Act serves a number of useful purposes. Approximately 1,000 men have been put to work, and many others will be added as other projects develop. On account of the character of the work a large number of these men necessarily are engineers.

The operations of the Coast and Geodetic Survey are admirably adapted to carrying out the purposes of the Relief Act. They provide for the immediate relief of unemployment without large overhead expenses or the creation of continuing obligations, and at the same time they produce results of lasting value which are widely used during normal times and are also urgently needed in the prosecution of other relief projects. As much of the work is regional and as the bureau has a policy of moving only key men to new localities, employment is widely distributed.

Work for this year

The work to be accomplished during the present year consists chiefly of control surveys and of surveys to modernize the coastal charts.

The control surveys are part of a plan to cover the entire country with a network of triangulation so that no point will be more than 25 miles from a triangulation station. This requires that the chains be not more than 50 miles apart. Eventually it is contemplated that these distances will be reduced to 25 and 12 miles respectively. Engineers are able to appraise what this would have meant in saving of expensive detached surveys often with alternative routes; in avoidance of errors in boundaries of properties and political units; in the prevention of costly litigation, and in many other respects if the country could have started off with such a system.

That this plan is approaching realization is evidenced by the fact that at least 12,000 miles of triangulation will be completed during the fiscal year ending June 30, 1934.

The triangulation chains are chiefly north-south or east-west so as to fit into the existing network. Work will be done during the year in most parts of the country but especially in the region from the Great Lakes to the Gulf including Florida, from North Dakota to Oklahoma and connecting links of considerable length in the Western mountain region and Pacific Coast region.

First-order leveling

In precise first-order leveling the proposed spacing of lines is the same as for the triangulation—50 miles apart. It is probable that greater use of benchmarks is made by engineers than of triangulation points. The addition of about 35,000 miles of leveling to the previous 85,000 will bring the aim much closer to realization. This work will be done in about 80 per cent of the states.

Progress in both these classes of work is essential to the carrying on and extension of the mapping program also provided for by financing from NRA funds.

Coastal surveys

The coastal surveys are for the purpose of modernizing the charts. The entire program includes triangulation control, aerial photographic work, compilation of the topography from the photographs, and hydrographic surveys. Last year the triangulation was brought up to date for most of the coast from emergency construction funds. This year emphasis will be laid on the next two steps outlined above, though good progress will be made in the hydrographic surveys.

These plans include photographic compilation parties at five cities on the Atlantic Coast, including New York, and one on the Pacific.

There are numerous projects but those of special importance include work in the following sections of the country: Maine and Massachusetts; north and south shores of Long Island; the Hudson River; Chesapeake Bay and outside coasts of Maryland and Virginia; the region of the intracoastal waterways from South Carolina to Florida and thence to Texas; and along the Pacific Coast, especially in southern California. Work in southeastern Alaska, near Dixon Entrance and in western Alaska, Prince William Sound and the Gulf of Alaska will be continued under the bureau's regular appropriations.

In the region of the inland waterways new surveys are badly needed for the proper charting of such waterways, many of which have been deepened and otherwise changed. The work as a whole benefits all classes of vessels from the liner to the small launch and from ocean tramps to the fisherman and small freighter.

Tide and current surveys

Better knowledge of tides and currents is necessary for improved charts. Special projects carried out this year under NRA funds include a tidal and current survey of St. Johns River, Fla. Peculiarities in these features make the survey important to the navigator and the engineer. Tidal surveys that will provide better datum planes and better knowledge of local peculiarities are being made on the west coast of Florida, Georgia, California, Oregon and Washington.

The needed magnetic surveys which provide compass information for the charts and airway maps are being advanced somewhat in addition to excellent progress last year.

Seismic study continued

Earthquake investigations, which during the past two years have resulted in much information (especially knowledge of earth motions in strong earthquakes, needed for the design of buildings and other structures), are being kept alive by a small grant from NRA funds. The records of strong motion have proved especially useful in the design of some of the very large structures such as dams and great bridges that are being built in whole or part from funds advanced by the government.

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Arousing Local Interest

AT THE present time engineers have an opportunity for local community service in connection with the Recovery Act program that should not be overlooked even if viewed only from a purely selfish standpoint. After weeks of delay the Public Works Administration is organized to receive and pass upon applications for loans for municipal projects. State advisory committees were appointed some time ago; now state engineers have been named, and most of them have established offices where applications can be considered. All types of municipal and state projects may be financed by loans under the Recovery Act, the loan generally being in the neighborhood of 70 per cent of the cost of the project with a direct grant of 30 per cent of the cost of labor and material. There are no self-liquidating limitations for public works, as was the case under the Relief Act of 1932. Few communities are aware of the possibilities of the Recovery Act for financing needed facilities. Engineers who are familiar with the provisions of the Act, therefore, should undertake a local educational program, and those who are not familiar with its provisions should prepare themselves to do some missionary work. They should talk to Chambers of Commerce and to city councils; most of them will be found in a receptive mood. Above all, they should get in touch with the editor of a local paper and show him what other places are getting and the possibility of getting money for local projects. *Engineering News-Record* can and has said much editorially upon the possibilities of the Act and has circulated the information widely beyond the circle of its regular readers. But the scope of our comment in any one region is limited. It needs to be translated into the language of the locality and spread before the great majority of the citizens if it is to be effective in building up support for local projects. This the local newspaper can do, but it cannot always be stimulated into doing it just by sending a marked copy of this journal to the editor. It needs to be done by personal contact.

Beach Destruction Again

RECENT storm damages to beaches and shore property along the Atlantic coast emphasize again the waste of these valuable assets that each year brings to the coast states. Also, as shown again by the summary in this issue of the report of the Beach Erosion Board, these wastes are largely within the ability of engineering skill to eliminate if they are attacked as a broad public-works policy and not left to erratic private enterprise to control with limited funds and without concerted effort. With every study, like that summarized on another page, further knowledge is gained by engineers of wave and current action and of sand drift as they make and unmake ocean beaches. Often the accomplishment of long investigation appears indefinite, as in the present findings, but the forces being analyzed are stupendous and complex, and truth must be torn from them in fragments. Time is correlating the fragments of rational research, and the process of trial and discard of protective agencies is stabilizing practice; engineering can now approach the task of shore protection with the promise of definite accomplishment. The great problem still without promise of solution is how to arouse public interest in the preservation of the taxable values destroyed every year through neglect of public works for beach protection.

Flood Work Resumed

RESUMPTION of flood-protection operations on the lower Mississippi River is guaranteed by the allotment of nearly $37,000,000 from the public-works funds. With the $7,000,000 provided four weeks ago, the total desired by the Corps of Engineers for operations planned for the fiscal year ending next June is made available. With speed in re-advertising and awarding contracts for projects withdrawn or withheld from action, late fall will see a resumption of operations where they normally should have been started last spring. If favored by a dry fall and winter, levee construction contractors can fairly soon swing into active earth-moving and re-employment; revetment and dike construction are essentially low-water operations, and low water is not normally a fall and winter condition in the delta valley. In effect, the construction season of 1933 has been virtually lost from the continuous program of flood protection started in 1928. Certainty that delay will not be further prolonged is the welcome assurance of the appropriation of funds as announced last week. This money will see the valley states placed in a comparatively favorable position to defy flood, and it will prevent increased loss in equipment and men unemployed.

Prepare for Winter Road Work

CONTRACTS for roadwork let in October and November, which, in the Bureau of Public Roads' progress chart, published two weeks ago, are the peak months of the present year in commitments of federal funds, place all road work undertaken in northern states before next spring in the category of winter construction. Much of the work projected can be done in winter, and similarly there are many projects on which cold-weather operation to any considerable extent is impracticable, as the cost and the physical obstacles are prohibitive. Active employment in roadbuilding is then possible through the coming winter months, but it presupposes selection, planning and suitable procedure for winter operations.

As the situation of getting road money promptly into pay envelopes presents itself, the immediate problem of state highway departments is to select and plan road projects that submit themselves best to winter construction requirements. By the same token, contractors should line up their plant and procedure and adjust their costs to the conditions of work in cold weather. Both tasks are within easy possibility, as many operations in the past have shown, and as the extensive programs of Ohio and Michigan in the winter of 1931-32 demonstrate outstandingly. The ancient theory that all roadbuilding must cease when frost arrives has been proved to be

the veriest fiction. No road work need be stopped in winter if the emergency is great enough to warrant the expense, and much road work can be performed in cold weather at very small increase in cost.

In the calculations of state highway officials small cost increases obviously should not interfere with the greater necessity of getting men out of breadlines and onto payrolls. The Bureau of Public Roads has visioned the need in its instructions to speed contracts for grade-crossings and other operations capable of protection against cold. With quick action in planning pojects for winter construction, state highway departments can do much to remedy the late start in converting the $400,000,000 for unemployment relief through roadbuilding into the wages that will increase purchasing and stimulate business. They have the ability and have been given the means to undertake a great winter roadbuilding program; custom, tradition and penny-saving practices should not stand in the way of accomplishment. The previous records of emergency roadbuilding activity warrant belief that state highway officials will meet the situation.

The Engineer's Code

THE CODE of fair competition for engineers in the construction industry, in the form in which it is to be presented to the National Recovery Administration, is reproduced elsewhere in this issue. It is not a code for all engineers, nor even for all engineers in private practice, but only for those whose practice is concerned with construction. This fact needs to be emphasized. When it is recognized many questions as to the limited scope of the code are answered automatically.

The disunion of the profession of engineering and its lack of a central or representative organization never was more evident than it was in the work of preparing the code; it still is all too evident in the lack of any definite plan for administering and financing the operation of the code. With some trepidation the executive committee of the American Society of Civil Engineers stepped in and undertook the preparation of the code when it became evident that one would be necessary, and the Society now sponsors the code even though it may develop into a heavy burden before measures for distributing the cost equitably among all engineers in the construction industry are developed. The committee is to be commended for its courage in thus taking the leadership in the face of considerable opposition from within the organization. Its course of action was not so clearly marked as was that of the executive committee of the American Institute of Architects, for many mechanical and electric engineers and not a few chemical and mining engineers come within the code's limits.

A subject also brought into highlight by the code development work is the changing status of the profession and the almost complete failure of the older men within it to give any thought to the problem of younger engineers and of the subprofessional group. In the early days of the American Society of Civil Engineers the men in private consulting practice amounted to a large percentage of its mature members, and many of the younger men worked for them and hoped soon to hang out their own shingles. But today the major part of those who are classified as engineers are employees, with no prospect or intention of entering private practice, and only a small part of the civil engineering profession is in private practice; yet this part still dominates the thinking of the American Society of Civil Engineers. Thus it happened that in the code discussions it was only the aggressive tactics of those who recognize the problems of the young engineers and of the subprofessional group that resulted in the inclusion in the code of a provision directed toward improving their working conditions. Bitter experience has taught the hundreds of young engineers in the employ of our large cities that the only way in which they can gain a hearing is through collective bargaining; yet it looked for a long time as though the code would include provision only for collective bargaining by the subprofessional groups, so repugnant to many engineers was the thought of formally recognizing that professional men might "stoop to the tactics of trade unions."

Meanwhile, labor union representatives, recognizing this need for collective bargaining, are strengthening their hold upon the young engineers and subprofessional men. And it is significant to note here that in the architects' code the American Institute of Architects recognizes this problem by stating that "It is sponsoring the formation of affiliated state-wide organizations of persons pursuing or qualified for the practice of architecture to which every architect and every architectural draftsman resident within its state shall be eligible."

The engineering societies need to give thought to a like proposal. If they are to be of fullest service to the profession, they must assist in solving the problems of the subprofessional group, the draftsmen and other engineering assistants. These men are so dependent upon the members of the engineering profession as to make their problems its problems.

The code as now drawn can hardly be expected to put an end to unfair competitive practices, for it lacks definiteness on one major element in the competitive field, the subject of fees. A schedule of minimum fees was included in the first draft—as something to shoot at—but it got such a concentration of fire as to be put out of action completely. So many qualifications were considered necessary for each classification in order to make it applicable to varying conditions in the major sections of the country as to make any definite statement of little practical value. The code provides for the setting of minimum fees regionally, which may be a solution of the problem. It remains to be seen whether even the local groups can agree on minimum fees that will give the desired amount of flexibility and yet minimize the competition from the unscrupulous engineer or for that matter from college professors and other salaried engineers—another of the sore spots of professional practice.

The code as presented is long—much longer than the original draft and longer than the codes for many other branches of industry that would appear to have more justification for a long code. But engineers wish to be exact and specific, with the result that each review of the code produced new subsections and added qualifying phrases. The result is not altogether satisfying, but it must be realized that the code was hastily drawn and necessarily must be of temporary character in its present form. The important fact to recognize is that it is a most important step toward settling some of the profession's major business problems, regardless of whether the Recovery Act survives beyond the two years now set for it. Also, acceptance of some of the provisions now written into the code may mark the beginning of a new era of professional society recognition of the group problems of the younger men.

NEWS OF THE WEEK

Contract Signed for PWA Loan For Hudson Tunnel

A CONTRACT between the Public Works Administration and the Port of New York Authority for a loan of $37,500,000 for the construction of the Midtown Hudson Tunnel at New York, was signed on Sept. 1. Signing of the contract completed the agreement between the two bodies, reached a few days earlier, to finance the construction of a new vehicle tunnel at New York, with PWA funds, as announced in our issue of August 31.

With the funds obtained from the Public Works Administration the Port Authority expects to build one tube of its projected twin-tube vehicular tunnel from the neighborhood of 39th Street on the west side of Manhattan Island under the Hudson River to Weehawken, N. J., a distance of about 8,000 ft. The tunnel will be built in such a way as to minimize the cost of construction of the parallel tunnel when required. Entrance and exit plazas will not be clear to the full extent required for the two tunnels at the present time. The Port Authority already owns through subsidiary corporations or holds options on a considerable part of the land required for the plazas.

In the contract with the PWA the Port Authority agrees to the 30-hr. week for labor and will give preference as far as possible to residents of the metropolitan district.

The general plan provides for locating the New York Plaza at 39th St. between 9th and 10th Avenues with direct connections to six crosstown city streets by a new north and south street running between 34th St. and 42nd St. On the New Jersey side, the plaza will be in Weehawken with a surface connection extending to Bergenline Ave. at 32nd St. in Union City and with connections to Hoboken at the south end and Fort Lee on the north. When the second tube is built the surface highway to Union City will give way to an open cut running through Union City to North Bergen. The total estimated cost of the completed twin-tube tunnel will be $75,000,000.

In detail of its design, the new vehicle tunnel will be very similar to the present Holland Tunnel, each tube of which has a roadway wide enough for two lines of vehicles. The shield-driven section under the river will be of cast iron and the Port Authority expects to be ready to call for bids on 50,000 tons of cast iron segments and 2,000 tons of special bolts and nuts within the next three weeks. Soon thereafter the bids will be called for sinking the ventilation shaft on the New York side as the first unit in the actual construction operation and it is hoped to have specifications ready for the general construction contract in time to get the work started within 60 or 70 days. Members of the engineering staff of the Port Authority are being recalled to assist in speeding up the completion of the plans and specifications.

The new tunnel will be 2½ miles north of the Holland Tunnel. Its construction by the Port Authority was authorized by the States of New York and New Jersey in 1931 when control of the Holland Tunnel was turned over to that body. As then proposed, each tube was to have an outside diameter of 31 ft. and a roadway 21 ft. wide or 1 ft. wider than that in the Holland Tunnel.

The loan to the Port Authority is to be made on its 10-year note at 4 per cent interest; $10,000,000 made available for the first year's work. Security for the note will be the revenue that will accrue on the project after the payment of operating and maintenance expenses. The notes will have recourse to the general reserve fund of the Port Authority in cast the tunnel in any year fails to earn its full interest charges. Provision is made in the agreement for the earlier payment of the note as soon as long-term permanent bond can be marketed on an agreed basis.

New Department in Oklahoma To Direct Flood Control

Governor Murray of Oklahoma has organized by executive order a new Department of Waterways, Power and Flood Control, consisting of three members, and designed to provide adequate consideration and determination of proper flood control, power development, river levee and lake construction work, as well as various municipal lake projects, and to co-operate with the federal government in its public works program for Oklahoma.

The new department is to have jurisdiction of all matters of flood control, irrigation, navigation and power on waterways of Oklahoma. Governor Murray said the jurisdiction of the department is to extend to all projects where federal, state, county, district and municipal aid is furnished.

Col. Clarence B. Douglas of Tulsa was named chairman, E. E. Blake of Oklahoma City as vice-chairman, and H. A. Hatcher, manager of the Oklahoma conservation department, as secretary.

Tentative Allotments for Local Projects To Be Made by PWA

Washington Correspondence

IN AN EFFORT to speed up local projects, the Public Works Administration will make tentative allotments on a prima facie showing, upon the condition that complete information on engineering and financial features will be forthcoming in time for execution of final contracts within 30 days.

Commenting on the resolution adopted by the Public Works Board, Secretary Ickes said that "this puts the responsibility just where it belongs." The administrator said that he is not satisfied with the speed with which states, cities and other non-federal bodies are presenting their projects and the manner in which they are laying before the Public Works Administration the information needed by the board so that it can act intelligently on proposals.

"States and municipalities have been slow to present projects and, in some instances," said Secretary Ickes, "the excuse is that, without assurance of favorable consideration, there is no justification for incurring the expense involved in preparing a project."

It was to meet this situation that the board decided to receive proposals without putting applicants to the time and expense of making a full presentation and to make tentative allotments to all for which there is a proper prima facie showing. That will expedite consideration of projects in Washington but in order that applicants also will act with celerity in bringing projects forward, the tentative allotments will lapse unless applicants follow through promptly with a complete presentation.

Secretary Ickes stated on Sept. 5 that several local projects have been approved by the board and are ready to submit to President Roosevelt. Asked whether all projects for which allotments are made will be submitted to the President, Secretary Ickes replied in the affirmative.

State advisory boards now are forwarding proposals to Washington at the rate of 15 to 20 a day. Many apparently have ben delayed because of questions concerning their eligibility. This situation may be remedied to some extent by the board's decision to give preliminary consideration to all proposals without requiring full particulars.

The text of the resolution adopted by the Public Works Board to brings forward more local projects reads:

"Resolved, that upon a proper prima facie showing that a proposed state or municipal public works project is socially desirable, is satisfactory from an engineering point of view, and can be financed under the law, the Public Works Administration may make an allocation of the money required for such project on the condition that not later than thirty days after such allocation, the financial and engineering features of said project be worked out and a final contract, satisfactory to the administrator of public works, be executed, failing which the tentative allocation shall be without effect."

"Under this resolution," said Secretary Ickes, "projects may be presented for consideration, provided, on their face, they come within the scope of the Industrial Recovery Act and the regulations of the board for public works. If the board considers the project desirable, it will make tentative allocation of the funds necessary to complete it, upon which the engineers, lawyers, and financial experts will proceed to make an intensive study

so that a final contract can be executed within not less than thirty days."

"This action of the Public Works Administration puts its distinctly up to the states or municipalities who have desirable public works projects presented to get busy."

Drafting of a contract for construction of the low dam at Grand Coulee is waiting upon adoption by the Public Works Administration of a contract form including provisions with respects to wage rates and hours of labor. This question apparently will not be disposed of until the construction industry's code is approved.

Of the total allotment of $63,000,000 made by the Public Works Board for this project, 30 per cent or $18,900,000 constitutes a grant. The remainder will be repaid by the state out of power revenues. Independent of the contract for construction of the dam proper, is the Columbia Basin Commission's call for bids Aug. 24 for core drilling and test work at the site under cooperative arrangement with the Reclamation Bureau covered by a contract of June 30 for field investigations and the preparation of plans and estimates. For this preliminary work the State Emergency Relief Commission contributed $377,000. Because the basin commission's contract with the reclamation service follows the usual practice under the reclamation act and because the expense of this exploratory work will be met by a state agency, the provisions of the National Recovery Act with reference to wages and hours of labor do not apply. The contract for construction of the dam will, however, be governed by the labor provisions of the new law, the construction code and the agreement which the trade unions have with the Public Works Administration.

An allotment of $2,250,000 was made on Sept. 5 for completing the Naval Hospital at Philadelphia.

Water Utilization Program Approved by Colorado Board

A program for a regional development to control and utilize the water supply of the high mountain regions of Colorado, calling for loans of from $150,000,000 to $200,000,000 from the federal public works fund, has been approved by the state advisory board of the public works administration.

The report, prepared by George M. Bull, state public works engineer, has been forwarded to Washington. It lists twenty-two projects, ranging from dams to transmountain diversion tunnels, designed to conserve the waters of the South Platte, Rio Grande, La Plata, Colorado and North Platte rivers, costing $137,450,000. Additional projects which would become desirable as a regional program is worked out would cost $50,000,000 or more.

The purpose of the plan is to minimize flood damage over a wide area, settle many interstate controversies over water, develop much arid land in Colorado and neighboring states and make more water available for domestic purposes. The report contemplates a regional plan of repaying the loans from the federal fund over a long period, the expense to be borne by the state and interests affected in proportion to benefits.

PWA Legal Department Disapproves Power Project

The legal department of the federal public works board at Washington has disapproved the application for a loan of $2,600,000 for the construction of a dam and hydro-electric plant at Red Bluff on the Pecos River, Tex., and a water storage reservoir for supplying a number of irrigation districts near Barstow. Federal engineers had approved the project.

Cities on Niagara Frontier Plan Sewage Commission

Plans to speed the creation of a Niagara Frontier District Sewage Commission were taken up Sept. 1, in Buffalo, N. Y., at a meeting of representatives of the interested cities and towns. The total cost of the project to end pollution of the Niagara River is placed at $29,500,000 to be borne as follows: Buffalo $17,000,000; Niagara Falls $5,000,000; Tonawanda and North Tonawanda $3,000,000; Grand Island $1,000,000; Lancaster $150,000; Williamsville $100,000; Kenmore $150,000. The general plan is to have the commission borrow funds to carry out the works with the several municipalities being charged an annual sum for payment of principal, interest, operation and maintenance. The suggestion has been made by some of the representatives that federal engineers be employed to draft the plans instead of engineers employed by the commission in order to reduce costs.

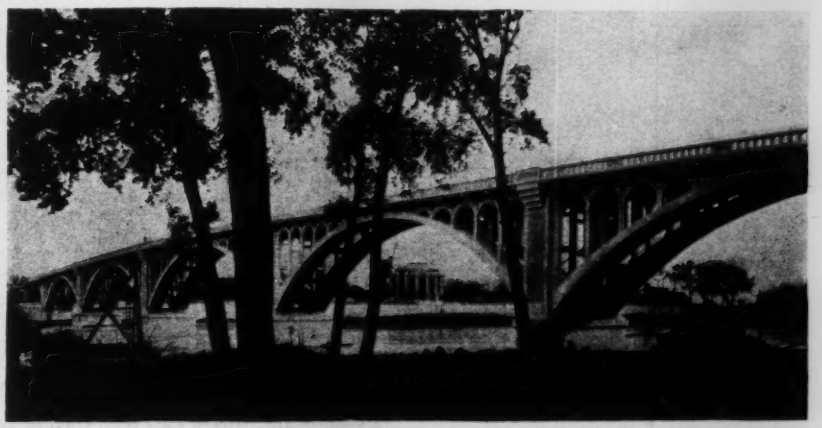
TVA Appoints Consultant On Cove Creek Dam

C. H. Locher has been retained by the Tennessee Valley authority to act as consultant in the construction of the Cove Creek Dam. Among the larger projects on which Mr. Locher has handled extensive contracts are the Chicago Drainage Canal, channel deepening in the St. Mary's River and the Detroit River, regrading in Seattle and water-supply tunnels and subways in New York City. He also was in charge of construction for the Miami Conservancy District in Ohio, where he built five large dams and extensive levees. No announcement has been made as to what extent Mr. Locher will devote his time to the Cove Creek Dam work, but his association with it is considered to assure sound methods of planning and executing the job.

Concrete Pavement Yardage

There is given below a tabulation of concrete pavement yardage awarded in the United States during the month of July, divided according to roads, streets and alleys, and the total for the first seven months of this year.

	Square Yards Awarded During July, 1933	Total Sq.Yd. Awarded to Date, July 29,1933
Roads	878,787	12,324,584
Streets	513,328	1,839,064
Alleys	35,578	120,008
Total	1,427,693	14,283,656



MEMORIAL BRIDGE AT VINCENNES, INDIANA, DEDICATED

The new bridge over the Wabash River at Vincennes, Indiana, built as a memorial to Gen. George Rogers Clark, the explorer, was formally dedicated on September 3. Consisting of seven open-spandrel concrete arches, the bridge is of an imposing appearance, which will be augmented by a large plaza in Vincennes and the construction of a memorial building which may be seen in its uncompleted state through one of the arches in the above view. The plaza is on the site of old Fort Sackville. The Wabash River being a navigable stream, the center arch was given a span of 180 ft. and an underclearance of 36 ft. It is flanked on each end by arches of 170, 145, and 80 ft., these span lengths giving the same span-rise ratio as the center span, with the whole bridge on a vertical curve. A 20 ft. roadway on a 5 per cent grade and two 5 ft. sidewalks comprise the deck. An article in *Engineering News-Record* Nov. 20, 1930, p. 811, describes the old bridge, built in 1863, that the new crossing replaces. The new bridge is a joint undertaking of the Indiana and Illinois highway departments but was designed in the Indiana bridge office under the direction of Fred Kellam, present engineer of design. William J. Titus was chief engineer of the department at the time the bridge was built. The Illinois approach work was carried out under the direction of Frank T. Sheets, former state highway engineer and George F. Burch, bridge engineer. The contractor for the bridge was the Ferguson Construction Co., Rockford, Ill., who followed the rather unusual procedure of building the upstream rib all the way across the river and then shifting the falsework and building the downstream rib. Truss-type falsework was used, requiring a minimum amount of piling in the stream. The memorial plaza and building, for which Bennett, Parsons & Frost, Chicago, are the architects, is being financed jointly by the state of Indiana and the federal government.

Rivers and Harbors Projects Approved by PWA

Approval by the Public Works Administration on August 31 of 90 rivers and harbors projects totaling $70,000,000 brought the total of allocation from the public works fund to $1,397,896,138.

The largest single project in the present approval is the work on the Kanawha River in West Virginia, which will cost $6,650,000. The plan calls for completion of a number of locks and replacement of a number of obsolete dams.

Other important allocations include levies and outlet enlargements for the Caloosahatchee River and Lake Okeechobee in Florida, at a cost of $2,400,000; channel stabilization in the Mississippi, Ohio and Illinois rivers, to cost $3,000,000; deepening the channel and dredging an anchorage basin in Toledo Harbor at a cost of $2,930,000; and the construction of bridges and widening Cape Cod Canal, estimated to cost $4,600,000.

The present allocation makes a total of $139,653,108 for work on rivers and harbors and flood control, under the public works fund. Previous allocation was $44,000,000 for flood control work and $25,653,108 for rivers and harbors in the Mississippi and Missouri rivers.

Offices Established for State Engineers of PWA

Since the publication of the list of state engineers of the federal public works administration in *Engineering News-Record*, August 17, 1933, p. 208, several changes have been made and definite office addresses have been established. The present state engineers and their office addresses are as follows:

ALABAMA—Not listed
ARIZONA—Howard S. Reed
Phoenix
ARKANSAS—Alex Allaire
New P. O. Bldg., Little Rock
CALIFORNIA—Frank E. Trask
State Bldg., Los Angeles
COLORADO—George M. Bull
229 Custom House, Denver
CONNECTICUT—Leslie A. Hoffman
Hotel Stratfield, Bridgeport
DELAWARE—Chas. H. Fleming
State House, Dover
FLORIDA—James E. Cotton
Tallahassee
GEORGIA—J. Houston Johnston
722 Citizens & Southern Bk. Bldg., Atlanta
IDAHO—Ivan C. Crawford
State House, Boise
ILLINOIS—Joshua D'Esposito
U. S. Court House, Chicago
INDIANA—Albert H. Hinkle
401-D Fed. Bldg., Indianapolis
IOWA—P. Frank Hopkins
State House, Des Moines
KANSAS—Robert J. Paulette
Topeka
KENTUCKY—Robert V. L. Wright
267 Fed. Bldg., Louisville
LOUISIANA—Orloff Henry
714 Masonic Temple, New Orleans
MAINE—Geo. M. Williamson
Portland
MARYLAND—Abel Wolman
1245 Balt. Trust Co., Bldg., Baltimore
MASSACHUSETTS—Charles R. Gow
307 State House, Boston
MICHIGAN—Mortimer E. Cooley
10 Fisher Bldg., Detroit
MINNESOTA—William N. Carey
1246 Univ. Ave., St. Paul
MISSISSIPPI—Geo. H. Wells
241 Edwards Hotel, Jackson
MISSOURI—Hugh Miller
Buder Bldg., 7th and Market Sts., St. Louis
MONTANA—D. A. McKinnon
Fed. Bldg., 219 Helena
NEBRASKA—Albert C. Arend
420 Fed. Bldg., Omaha
NEVADA—With Utah
NEW HAMPSHIRE-VT.—Harold J. Lockwood
State House, Concord, N. H.
NEW JERSEY—Cornelius C. Vermuele, Jr.
Indus. Bldg., 1060 Broad St., Newark
NEW MEXICO—With Arizona
NEW YORK—Arthur Tuttle
Capitol, Albany
NORTH CAROLINA—Herman G. Baity
Chapel Hill
NORTH DAKOTA-S. D.—Harry C. Knudson
Fed. Bldg., Devils Lake, N. D.
OHIO—L. A. Boulay
Wyandotte Bldg., 6th floor, Columbus
OKLAHOMA—Philip S. Donnell
Fed. Bldg., Oklahoma City
OREGON—Claude C. Hockley
Fed. Bldg., Portland
PENNSYLVANIA—Wm. H. Gravell
Cap. Bldg., Harrisburg
RHODE ISLAND—With Connecticut
SOUTH CAROLINA—J. L. M. Irby
Columbia
SOUTH DAKOTA—With N. Dakota
TENNESSEE—Harry S. Berry
Nashville
TEXAS—Robt. A. Thompson
Fair Bldg., Fort Worth
UTAH-NEVADA—Richard Ambrose Hart
Fed. Bldg., Salt Lake
VERMONT—With New Hampshire
VIRGINIA—James A. Anderson
337 P. O. Bldg., Richmond
WASHINGTON—Gene Hoffman
Olympia
WEST VIRGINIA—M. Lindsay O'Neale
Charleston
WISCONSIN—James L. Ferebee
Madison
WYOMING—Francis C. Williams
Cheyenne

New York State Law Permits Cities to Obtain Funds from PWA

Governor Lehman has signed a bill passed by the recently adjourned special session of the New York State Legislature, which declares a public emergency and enables municipalities and public bodies to secure the benefits of the provisions of the National Industrial Recovery Act. By the terms of the new law, the governing board of a municipality is authorized to enter into contracts with the federal PWA to obtain funds for public works projects and to sell its bonds or other obligations to the PWA without advertisement, proposals or public or private bidding, "notwithstanding the provisions of any general, special, or local law." There is a provision that if under existing law the public works to be constructed are to be paid for by direct assessment on real estate benefited where the area of the benefit is less than that of the municipality, any existing provision for a permissive referendum shall remain in full force and effect. All provisions of the act applicable to municipalities and public bodies may also be availed of by the state itself.

Bureau of Standards Transfers Work to A.S.A.

For the sake of economy, work which has been carried on by the Bureau of Standards in the field of simplification, commercial standards, safety codes and building codes, has been turned over by agreement to the American Standards Association of New York. Howard Coonley, president of the association, has declared that every effort will be made to continue satisfactorily the work of the Bureau of Standards. Secretary of Commerce Roper has assured the association that the full cooperation of the Bureau would be available at all times in providing at least a part of the research work necessary to the standardization projects.

The transfer of activities will involve the work heretofore done by the Division of Simplified Practice, Building and Housing Specifications, and Trade Standards, and the Section of Safety Standards.

Labor Rates and Restrictions Set for Columbia River Work

Rates of pay for skilled and unskilled labor, maximum hours, and restrictions both upon laborers and upon contractors bidding upon the first work to be undertaken at the Grand Coulee dam have been set by the Columbia Basin Commission in the call for bids for core drilling and test work at the dam site. Late in July the Public Works Administration agreed to loan $63,000,000 to the Columbia Basin Commission to finance the first stage of construction on the proposed Grand Coulee dam and power plant for the $400,000,000 Columbia Basin power and irrigation project (*ENR*, Aug. 3, p. 145). Subsequently the commission called for bids on the test work at the dam site, the first work to be undertaken, and on Aug. 21 it adopted a resolution modifying the call for bids. This resolution set up conditions of work and rates of pay which are expected to establish a precedent for the work. Contract for the loan has not been completed, as noted elsewhere.

Contractors and subcontractors on the Columbia Basin work must be resident citizens of the state of Washington or corporations organized under the state laws, or must have operated continuously within the state for five years prior to date of bid. All employees except those in executive capacity must be resident citizens.

Hours of work are set at a maximum of 36 in one week and six in one day. Minimum wage rates are set at $0.60 per hour for unskilled and $0.80 for skilled.

These rates appear to conflict with those set by the Public Works Board (*ENR*, Aug. 24, p. 238) for "all construction financed from funds appropriated by the Administrator of Public Works under authority of the National Industrial Recovery Act." The rates so set for the state of Washington (Northern zone) are: unskilled labor, $0.50; skilled labor, $1.20. The hours of labor also conflict with those set by the Recovery Act itself which stipulates a 30-hr. week.

The labor provisions of the Recovery Act stipulate that first preference shall be given to ex-service men and then to residents of the political subdivisions in which the work is performed if available and qualified. Restriction of contractors to residents of the state in which work is to be performed is contrary to the practice adhered to by the Bureau of Public Roads on all state work financed with federal funds.

Unemployment in Engineering Decreasing in Colorado

Rapid depletion of the reservoir of 300 unemployed engineers listed last winter with the Colorado Society of Engineers is taking place, according to the Society's unemployment service. More than 125 men, mostly civil engineers, have been put to work within the last few months. The civilian conservation corps absorbed the first large group, but there is a continuing draft at present and for several specialty places the service has not been able to find qualified men. The state highway department, the city of Denver, and the office of the United States Bureau of Reclamation are rapidly increasing their engineering staffs from civil service lists and from their former employees.

Numerous Communities Apply For TVA Power Service

More than 50 communities have requested the Tennessee Valley Authority for light and power service. The demand far exceeds the present supply but every application is being considered with a view to determining the requirements of each locality and the rate structure that should be established. The list of formal and informal applications includes: Alabama: Courtland, Decatur, Florence, Hillsboro, Leighton, Moulton, Sheffield, Tuscumbia, Wheeler; Georgia: Augusta and Dalton; Kentucky: London and Paducah; Missouri, Cape Girardeau; Mississippi, Aberdeen, Amory, Belmont, Booneville, Coffeeville, Columbus, Corinth, Fulton, Houston, Iuka, Macon, Nettleton, Prairie, Starkville, Tupelo, and West Point; Tennessee, Beans Creek, Bells, Blanche, Bolivar, Dyer, Elora, Flintville, Grand Junction, Henderson, Huntland, Jackson, Kenton, Lebanon, Martin, Maxwell, Milan, Newport, Parsons, Pulaski, Rutherford, Selmer, Toone, Trenton, Union City and Whiteville.

Preliminary Work Well Started On San Francisco-Oakland Bridge

Preparations for the start of actual pier construction on the San Francisco-Oakland bridge are being gradually accelerated. During the last week employment was increased by 200 as operations were expanded. A minor labor disturbance occurred with the strike of 70 welders in the shipyard where the caissons are being fabricated. The welders, according to report, were receiving 72c. per hour and struck after making demands of more than $1.00 per hour. They were engaged in welding sections of the caissons and no other part of the work was held up.

On the San Francisco anchorage the Healy-Tibbitts Const. Co. has overcome sliding earth which was interfering with excavation work and has begun, the erection of a concreting plant. The Transbay Const. Co. has foundation work actively under way at three points in the bay between the city and the island. At the first main pier location, near the San Francisco pier-head line, the 52 by 122-ft. steel sheet piling cofferdam has been completed and jetting has been started to aid in cleaning out the silt and clay down to rock. Excavation will be completed and ready for concreting within two weeks.

In the middle of the channel at the site of the large central anchorage working platforms on timber piles and steel cylinders for permanent derricks have been constructed. On the site of Pier No. 6, nearest the island, surveys have been made to locate the 125-ton concrete anchors which will be used to hold the caisson in position. Present plans call for towing this first caisson into position about the middle of September.

Preliminary work for the island operations including the tunnel and the cable anchorage has been well advanced by the Clinton Const. Co. Roads to the tunnel portals are almost completed and docks and muck disposal chutes are being built.

Foundation work on the section east of the island is not as far advanced but is being speeded. Bridge Builders, Inc., has completed derrick platforms at two pier sites and has accumulated large supplies of timber and steel for rushing caisson construction. The concrete plant of Henry J. Kaiser, Inc., which will supply all pier operations is practically ready.

The first section of a submarine power cable for construction work has been laid from the San Francisco side to the central anchorage. Other sections will be added to provide a continuous cable along the entire bridge length with outlets at each pier for the contractors' operations.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual meeting, Chicago, Ill., Oct. 3-6, 1933.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Milwaukee, Wis., Oct. 9-11.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, Chicago, Oct. 17-21.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Indianapolis, Ind., Oct. 9-12.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Milwaukee, Wis., Sept. 25-27.

AMERICAN WELDING SOCIETY, fall meeting, Detroit, Mich., Oct. 2-6.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 7-8.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, annual meeting, Milwaukee, Wis., Sept. 21-23.

INTERNATIONAL CITY MANAGERS ASSOCIATION, annual conference. International House, Chicago, Sept. 18-20.

NATIONAL SAFETY COUNCIL, 22nd Annual Safety Congress, Chicago, Oct. 2-6.

NATIONAL ASSOCIATION OF RAILWAY AND UTILITIES COMMISSIONERS, annual meeting, Cincinnati, Ohio, Oct. 10-12.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, Bridgeport, Conn., Sept. 19-22.

ROCKY MOUNTAIN SECTION of the American Water Works association, will hold its seventh annual meeting at Denver, Colo., on October 24-26. The meeting will include a water works school under the auspices of the University of Colorado, which will include a course of lectures and laboratory and shop demonstrations.

NATIONAL RIVERS AND HARBORS CONGRESS will hold a special session at Chicago, Ill., on October 12 and 13. The purpose of the meeting is to consider the present status of the rivers and harbors, flood control and waterways program, and to formulate a legislative program for presentation at the forthcoming session of Congress in January, 1934.

Illinois Unemployment Body Presents Public Works Program

Turned over to the Illinois state advisory board PWA, by Governor Horner's Committee on Unemployment, was a program of public works projects obtained from more than 100 municipalities and other governmental organizations. It totaled nearly $120,000,000, of which one-quarter ($29,653,000) was from cities, towns and villages outside of Chicago and Cook County where $77,400,000 was asked for. The great majority of the outside municipal projects were for water and sewage improvements. State projects totaled $3,557,000; park boards, $1,350,000; sanitary and drainage districts, $5,615,000; school boards, $1,389,000 and county projects, $575,000. The large items in the $77 million Chicago-Cook County program include $36,500,000 for the Sanitary District, $22,000,000 for filtration, $9,000,000 for an outer bridge over the Chicago River and other smaller items.

Brief News

TWO HUNDRED conservation army workers left Fort Logan, Colorado, August 16 for Parker, Colorado, where they will repair damage done by the overflow of Cherry Creek, after a cloudburst.

A MOVEMENT has been started in Wayne County, N. Y., to request the governor and legislature to put through a bill to buy right-of-way and allocate a sufficient amount of Federal funds that have been put aside for New York state to build a wide highway on the road bed of the old 97-mile line of the Rochester and Syracuse Trolley line.

A SPECIAL election to vote on a $3,000,000 sewer bond issue has been called by the city council of Tacoma, Wash., for Sept. 26. The proposed project will provide for the construction of about 33 miles of trunk sewer, including an interceptor to take the sewage into deep water, and three pumping plants. The plan is to apply for federal financing through the PWA. The project would provide employment for about 1,000 men.

THE EMPLOYMENT of a board of four consulting engineers to investigate and report on the Calalco reservoir and attendant dam sites for the Metropolitan Water District of Southern California was authorized by the district board of directors on Aug. 4. The engineers named are: Thaddeus Merriman, chief engineer of the New York City Board of Water Supply; Charles D. Marx, professor emeritus of civil engineering, Stanford University; J. L. Savage, chief designing engineer, Bureau of Reclamation, Denver, Colo., and Col. Charles T. Leeds, member of the firm of consulting engineers of Quinton, Code, Hill, Leeds and Barnard, Los Angeles.

Personal Notes

JOHN F. COLEMAN, consulting engineer of New Orleans, La., has resigned as a member of the Engineers' Advisory Board of the Reconstruction Finance Corp.

TIMOTHY HARRINGTON has been appointed city engineer of Madison, Wis., to succeed E. E. Parker, who recently resigned to accept a position as deputy state highway engineer.

EDWARD W. RITCHIE of the engineering firm of Ritchie-Van Siller, has been appointed as examining engineer with the National Emergency Administration and will be located temporarily in Washington, D. C.

JOHN H. GREGORY, consulting engineer, and Professor of Civil and Sanitary Engineering in the Johns Hopkins University, has resigned as a member of the Engineers' Advisory Board of the Reconstruction Finance Corp.

W. M. HOGE, Major, Corps of Engineers, and chief of operations of the Memphis Engineer District, became acting district engineer on Aug. 2 when Major E. C. Kelton was assigned to the Army War College at Washington.

W. W. ZASS, who has been acting chief engineer of the Arkansas State Highway Department since Feb. 1, has been appointed chief engineer by the state highway commission. He has been associated with the department since 1923, first as office engineer, until 1927, and as construction engineer from 1927 to Feb. 1, 1933.

H. S. CROCKER, Denver consulting engineer, has resigned as a member of the Denver water board and has accepted the office of advisory engineer to the City of Denver, Colorado, on the various projects to be included in the new public works program.

AXEL H. OXHOLM, of Washington, D. C., has been appointed chief of the Lumber Division, Bureau of Foreign and Domestic Commerce. Mr. Oxholm was originally appointed chief of the Lumber Division in July, 1921, resigning from that position in December, 1925, to become director of the National Committee on Wood Utilization.

J. M. PAGE was on July 27 named senior federal highway engineer for Arkansas to succeed Frank D. Hudgins, who died a few days ago. Mr. Page was formerly state highway engineer for Oklahoma. He is a native of Baltimore, Md., and has been connected with the state highway departments of Maryland, Delaware and Virginia. He was with the U. S. Bureau of Roads for about ten years.

WILLIAM STOECKER, head of the William Stoecker Engineering Company, Webster Grove, Mo., on August 8 was appointed by Governor Guy B. Park to serve as one of the members of the Missouri State Public Service Commission. He succeeds Milton R. Stahl, one time chairman of the commission, who resigned recently, and will serve until April 15, 1935.

JAMES W. OWENS, welding consultant, and formerly director of welding of the Newport News Shipbuilding & Drydock Co., has been appointed director of the new welding division of the Pittsburgh Testing Laboratory known as the National Weld Testing Bureau. The services of this bureau will cover reports on welding processes, qualification tests, welded specimens during construction and laboratory tests of weld specimens, as well as investigations of welded products and structures and special welding problems.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly Sept., 1932	Average Four Weeks	Week Sept. 7, 1933
Federal Government	$4,670	$895	$946
State and municipal	15,464	8,646	8,715
Total public	$20,134	$9,541	$9,661
Total private	2,763	6,143	4,536
Week's total	$22,897	$15,684	$14,197
Cumulative to date:			
1932		$846,001	
1933		584,258	

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Weekly Sept., 1932	Average Four Weeks	Week Sept. 2 1933
New capital issues	$3,750	$54,712	$40,434
Cumulative to date:			
1932		$521,350	
1933		698,540	

ENR Cost and Volume Index

E.N.R.-Cost		E.N.-R. Volume	
September, 1933	175.48	August, 1933	72
August, 1933	167.00	July, 1933	65
September, 1932	157.96	August, 1932	111
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 (Average)	100		

Obituary

ERNEST S. FENWICK, former well-known builder of Buffalo, N. Y., died August 27 in Washington, D. C., where he had been making his home recently.

RICHARD T. COINER, Lieutenant Colonel, Corps of Engineers, commanding the Eleventh Engineers at Corozal, died at Balboa, Canal Zone on August 31. He was born in Iowa on December 26, 1882.

PRESTON B. WITTMER, deputy state tax commissioner of New York, died at Albany, N. Y., on August 30. Mr. Wittmer was formerly in the engineering department of the Pennsylvania Railroad, later was assistant engineer for the West Shore and New York Central Railroad and still later chief engineer of the Pittsburgh and Conneaut Company.

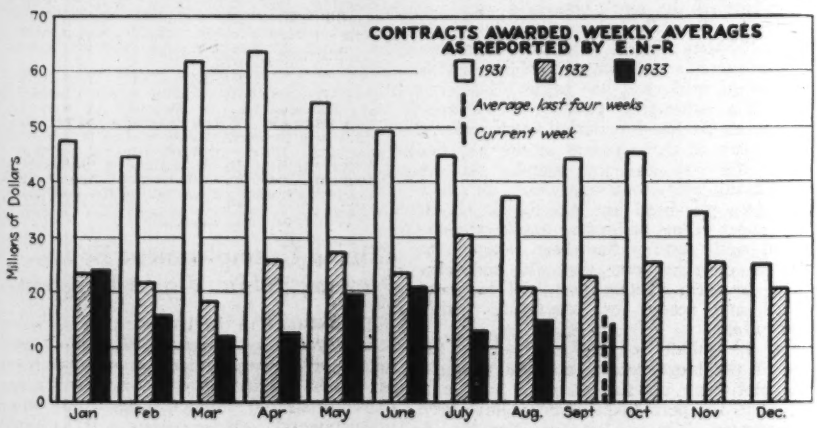
WILLIAM PERCY HAYES, an engineer for the St. Louis County Highway Department, died at his home at Clayton, Mo., on August 25 at the age of 47. He was a native of St. Louis and had been educated at St. Louis University. He was division superintendent of the Missouri Pacific Railroad and later a highway engineer for the Arkansas State Highway Department before assuming the St. Louis County highway position.

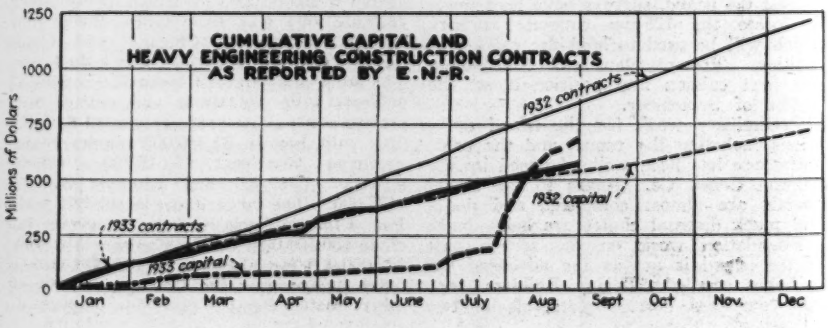
CHARLES F. STOWELL, for many years chief bridge engineer of the former board of railroad commissioners of New York and Vermont, died at Albany, N. Y., on August 31. He was 80 years old. Mr. Stowell was graduated from Rensselaer Polytechnic Institute in 1879 and became associated with the Hilton Bridge Works. Later he received his state appointment. He was associated with the firm of Stowell & Cunningham, and also with the Federal Construction Company.

Engineering Contracts and Capital

AWARDS of heavy engineering construction contracts last week, interrupted by the Labor Day holiday, fell off to $14,197,000 following a $19,115,000 total the previous week. Public works awards amounted to $9,661,000, a loss of less than 2 millions from the previous week, but private contracts fell off over 3 millions to $4,536,000. The average of all contracts awarded during the past four weeks is $15,684,000. Highway lettings, which had been showing a steady gain during the past month because of the $400,000,000 road program, slumped to $4,046,000 for the short week, about half of the previous week's total. Federal awards were slightly heavier than usual with $946,000 reported in contracts. The largest single contract reported during the week was that for the completion of the department of health building in New York, $3,233,000. Contract for the first private toll bridge in some time was let at Omaha for a new structure across the Missouri to cost $1,786,000. Nebraska let road contracts totaling $1,749,000.

The recent sprint in new capital figures was maintained by a federal loan of $37,500,000 for the mid-town tunnel across the Hudson at New York, bringing the total of capital issues for the week to $40,434,000. Cumulative new capital issues to date this year total $698,540,000, as compared with $521,350,000 for 1932.





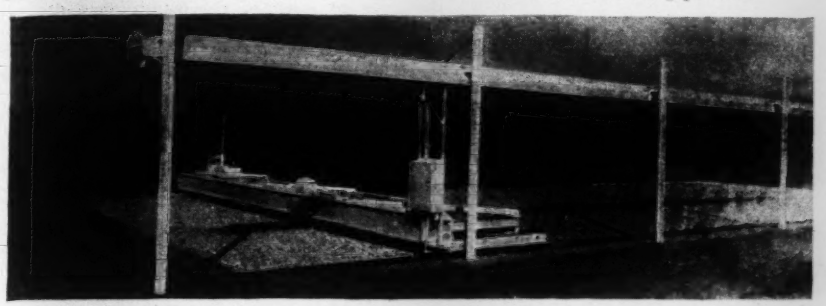
Construction Equipment and Materials

Traveling Sewage Distributor For Trickling Filters

Link-Belt Co., Philadelphia, Pa., announce that they have developed and are now manufacturing a new sewage treatment plant unit, which is to be known as the Link-Belt reciprocating distributor.

This distributor consists of a trough extending over the filter bed, carried on trucks at both ends. These trucks run on rails mounted on the walls of the filter.

In operation the machine works in the following manner: A section of the pipe is submerged in a well of the coating material, the material being confined in a cylindrical sleeve fastened around the pipe, one end of the sleeve being sealed to prevent leakage and the other end having a predetermined space between the collar and the pipe wall. This well of material is moved along the pipe, depositing a thickness of coating always equal to the space between the sleeve and the pipe wall.



Link-Belt reciprocating distributor for trickling filters

A channel runs the whole length of the filter bed, and the sewage is siphoned from it to the trough of the distributor. If the siphon should break, a vacuum pump restores it automatically.

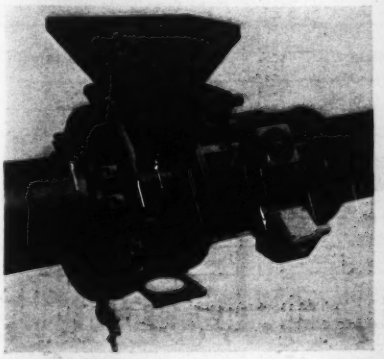
The sewage is distributed by means of V-notch slots in the trough. Under each notch is a spreader plate welded to the trough. From the spreader plate the sewage drops on to an angle which distributes the flow over a uniform area.

Power is transmitted to motors by an overhead trolley system. The machine is automatically reversed by switches at both ends of the filter bed.

Light-Weight Machine for Coating Pipe in the Field

Patents have recently been issued to J. B. W. Gardiner, 50 Church St., New York, N. Y., on a mechanical process and a light-weight, two-man machine for coating pipe in the field with bituminous material.

Machine for coating pipe in the field with bituminous material



The machine by which this process is carried out is divided into two compartments, a carriage or wheel system on which the machine rides the pipe, and a material compartment. The wheel system consists of a series of wheels, staggered around the cylinder. The strut supporting any wheel is forced to collapse when the wheel hits a weld, and is automatically sprung back into its vertical position when the weld is passed over. The coating nose, which is made up of a number of interlocking segments, is a cone section, heated when necessary by small burners using bottled gas.

New Equipment in Brief

Compressor. A new single-stage, belt-driven compressor, designed for heavy-duty service, is announced by Ingersoll-Rand Co., 11 Broadway, New York, N. Y. It is designated the Class ES. It has one horizontal, double-acting cylinder and operates at moderate speeds. It is available in sizes from 10 to 125 hp., and for discharge pressures from 5 to 150 pounds.

Emergency Light. For use as an emergency light on motor trucks, National Carbide Sales Corp., New York, N. Y., are offering the WL 1-CI lantern equipped with red rear light. The lantern burns acetylene gas and has a strong white light showing to the front and a red light to the rear.

Rubber V-Belts. A new and improved type of Goodyear Emerald Cord V-belt is announced by Worthington Pump & Machinery Corp., Harrison, N. J., in connection with the Worthington multi-V-drive. There are two variations of the new construction, one having one endless cord in one plane, and the other having two endless cords in two planes. All cords are completely embedded in rubber. The tension and compression sections of the belt are composed of rubber, with layers of fabric distributed through the compression section to prevent excessive flexibility.

Gunite Velocity Meter. The Cement Gun Co., Allentown, Pa., announces that as a result of tests carried on by the Water Department of Syracuse, N. Y., regarding the advantages of velocity meters in connection with the operation of the Cement Gun, a nozzle velocity meter has been developed which is to become a part of the new machine. The company announces that these meters are available for owners of machines bought before the development of this feature.

Torch Flame Regulator. The Alexander Milburn Co., Baltimore, Md., has developed a regulator for use with oxygen, acetylene and other gases, which has a dual adjustment comprising a fine micrometer adjusting key housed within and operating separately from the main regulator key. The maker states that this means of adjustment is so fine that fractions of an ounce of pressure can be obtained with the micrometer key.

New Publications

Water-Power Equipment. Newport News Shipbuilding & Dry Dock Co., 90 Broad St., New York, N. Y., has published a 60-page book entitled "Water Power Equipment," which describes and illustrates the installations at 32 different water-power plants and hydraulic laboratories. The installations described include such well known plants as those at Dnieprostroy, Calderwood, Conowingo, Muscle Shoals and Osage. The book is profusely illustrated.

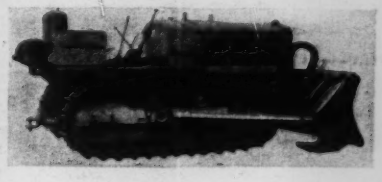
Stellite. Increased life and savings effected through the application of hard-facing materials to the wearing parts of excavting and dredging equipment are described in a 16-page booklet, "How Hard-Facing Saves Money for Contractors," issued by the Haynes Stellite Co., Kokomo, Ind. Several types of hard-facing materials are discussed, including the non-ferrous cobalt-chromium-tungsten alloys and welding rods consisting of particles of crushed tungsten carbide bonded together with steel. The greater part of the booklet is devoted to actual applications where the process has been used to protect wearing parts of excavating and dredging equipment. Among the applications discussed are dipper buckets, dragline buckets, clamshell buckets, dredging cutters, orange peel buckets, drag scraper teeth and cutters, ditcher teeth, tractor treads, hand shovels, and brake drums.

New Hydraulic Bulldozer

A new hydraulic bulldozer has been announced by the Athey Trussed Wheel Co., Chicago, Ill. It is a compact and rugged unit, adapted to either the Caterpillar 35 or 50 tractor.

The blade is of the moldboard type and can be furnished with detachable end cutting edges when specified. The blade and operating linkage of the bulldozer are mounted and carried on the track and roller frame assembly of the tractor. An equalizer assembly permits the full movement of each track assembly, without materially changing the level or movement of the blade. Control of the bulldozer is from the tractor seat, with "finger tip" selection between the various operating positions of the control lever.

New Athey bulldozer for use with Caterpillar tractor



Business Side of Construction

Road Awards Raise Contract Total; Cost Index Reaches Two-Year High

ACTUAL STARTING of the federal $400,000,000 highway construction program late in the month raised the total of heavy engineering contracts reported in August (five weeks) to $74,063,000, or an average of 14.8 millions per week, an increase of 17 per cent over the July average of 12.6 millions per week. Rising material and labor costs pushed the *Engineering News-Record* Cost Index up to 175.48, an increase of 8½ points over the August mark and the highest index figure since June, 1931. Lumber led the rise in construction commodity prices during the month, the lumber component in the Cost Index accounting for most of the jump in that figure.

Public works awards during August amount to $39,500,000, or an average of 7.9 millions per week, a considerable increase over the July average of 6.5 millions for this class of work. Federal government contracts dropped to an 8-year low for the month, averaging only $600,000 per week. Highway lettings averaged 4.5 millions per week, the highest since last January. Public buildings, due to the slump in federal work in this class, dropped to an average of $600,000 per week, the lowest in years.

The relating of weekly averages of contracts let for the entire month does not tell the story of what is happening in construction activity today. The increase in conracts let has occurred during the last two weeks at an accelerating rate. For the first three weeks of the month contract awards average about 13 millions. The next week's total rose to 16 millions, and the final week of August saw the contract total rise to 19.1 millions. The highway field accounted for most of this rise. During July and for the first two weeks of August road lettings averaged 2.7 millions. In the last three weeks of August the road figures reported were 3.7, 4.7 and 8.6 millions. It is expected that much of the $400,000,000 highway fund will be placed under contract by the end of the year.

Private contracts reported in August averaged 6.9 millions per week, the highest average for a year except the month of June. The trend in private work, however has not followed public works. Private contracts reached the highest weekly total of the month, 8.8 millions, during the second week of the month, then declined to 5.0 millions the fourth week, but recovered more than half of the loss with a total of 7.6 millions for the closing week.

Materials notes

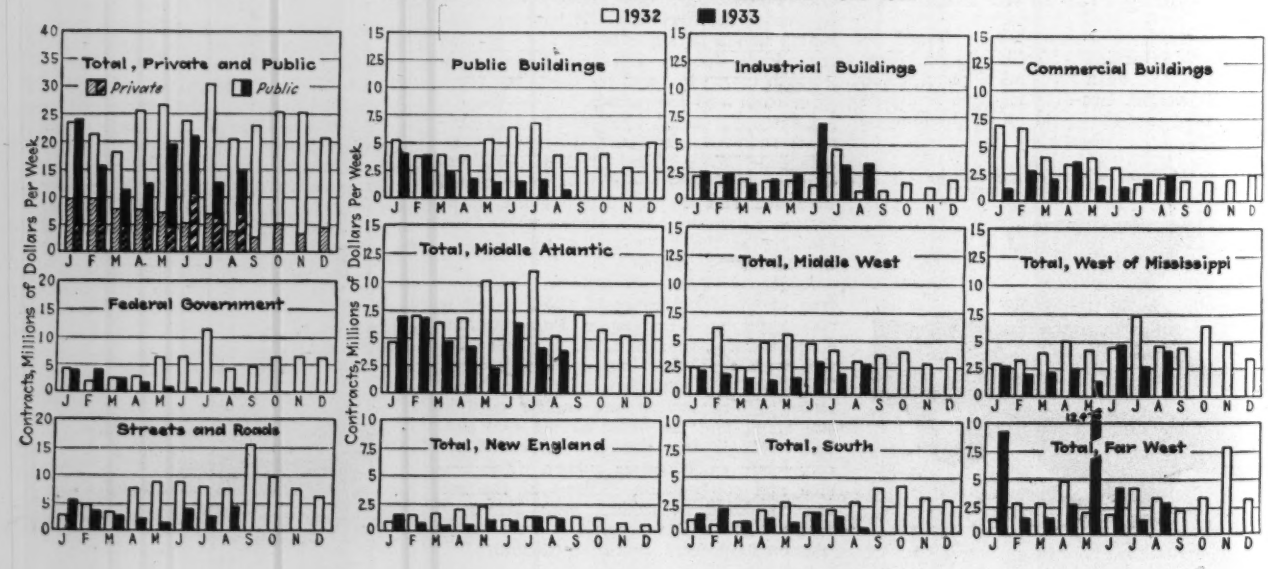
Construction commodity prices are far from stable at the present time. Nearly every industry contemplates price rises when the various codes are put into effect. Some industries have anticipated these rises with actual increases; others

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN AUGUST, 1933

Five Weeks—Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States Aug., 1933	United States Eight Months 1933	United States Eight Months 1932	Canada Aug., 1933
Public Works										
Waterworks	266	87	15	2,767	106	1,304	4,545	59,547	20,832	....
Sewers	85	170	....	779	317	44	1,395	11,318	16,738	229
Bridges, public	59	707	187	543	549	40	2,085	55,684	36,030	125
Earthwork and waterways	360	101	331	22	2,190	24	3,028	26,959	58,125	241
Streets and roads	1,713	4,356	958	3,806	7,877	3,748	22,458	117,208	219,524	1,811
Buildings, public	395	1,127	....	722	679	177	3,100	72,169	166,453	680
Unclassified, public	76	102	46	68	64	2,533	2,889	10,478	32,771	437
Total public	2,954	6,650	1,537	8,704	11,782	7,870	39,500	353,163	550,473	3,523
Federal gov't. (included in above classification)	2	14	173	174	2,023	596	2,982	60,551	166,914	....
Private										
Bridges, private	....	326	....	....	987	....	1,313	4,497	3,404	....
Buildings, industrial	1,301	6,125	435	4,710	2,163	2,391	17,125	107,094	67,651	558
Buildings, commercial	1,610	5,019	530	348	4,238	48	11,793	68,069	132,593	230
Unclassified, private	35	704	....	183	1,210	2,200	4,332	36,738	46,086	31
Total private	2,946	12,174	965	5,241	8,598	4,639	34,563	216,898	249,734	819
August, 1933 (5 Weeks)	**5,900**	**18,824**	**2,502**	**13,948**	**20,380**	**12,509**	**74,063**	.....	.....	**4,342**
July, 1933 (4 weeks)	4,903	16,186	5,852	7,499	10,317	5,611	50,368	.....	.....	2,354
August, 1932 (4 weeks)	5,588	20,624	11,019	12,500	18,177	13,726	81,634	.....	.....	7,068
Eight months, 1933	32,886	169,995	47,573	72,301	98,065	149,241	.....	570,061	.....	18,340
Eight months, 1932	53,839	286,346	61,225	143,470	152,575	102,752	.....	.....	800,207	34,074

CONTRACTS REPORTED - WEEKLY AVERAGES - 1932-1933



are waiting for increases in production costs before raising prices. Lumber prices are shooting upwards in many places. Again, adjacent territories report great discrepancies in lumber prices. Now that the lumber code, providing for control of production and prices, has become effective, it is expected the lumber price situation will become stabilized within the next few weeks. Structural steel products and cast iron pipe have not increased in price. Cement has remained stationary since the mid-July price rise. Sand, gravel and stone prices are fluctuating at the moment, some centers reporting slight drops in quotations, while rising prices are reported from other localities. Clay products are showing a tendency towards higher prices.

Cement—The portland cement industry in July produced 8,600,000 bbl., shipped 8,697,000 bbl., and had in stock at the end of the month 19,848,000 bbl., according to reports of the U. S. Bureau of Mines. Production showed an increase of 12.4 per cent and shipments a decrease of 5.7 per cent over the same month a year ago. Production in July was rated at 37.6 per cent of capacity, as compared with 35.2 in June and 33.4 a year ago.

Steel—From a rated output of 59 per cent during July, the production of steel ingots fell to about 50 per cent the closing week of August. Steel interests look for another rise in output later on this fall. The American Iron & Steel Institute reports a production of steel ingots during July of 3,205,810 tons, as compared with 2,597,517 tons in June.

Lumber—Production of lumber and orders received declined during August from July figures. A slight gain in orders was noted towards the last of the month, according to the National Lumber Manufactures Association. Lumber orders of the last few weeks are reported to have come mostly from dealers to replenish depleted stocks, rather than to meet consumer buying.

Labor notes

Labor rates in the construction industry are confusing at the present time. State highway departments, the federal administration, contractors' codes and labor organization demands all call for various wage scales on similar work. The country has been divided into three zones by the Public Works administration, each zone being assigned minimum rates as follows: Southern—skilled, $1.00, common, 40c.; Central—skilled, $1.10, common, 45c.; Northern—skilled, $1.20, common, 50c. Higher wage agreements made prior to April 1, 1933, between employers and labor, will be respected during the life of such agreements.

Highway scales — Various minimum scales announced by highway departments as required on state highway work, including projects financed by the PWA, are as follows: Arizona—common, 50c., skilled, 68¾c. to $1; Ohio—common, 47½c., skilled, 70c.; Idaho—common, 55c., skilled, 65c.; Oklahoma—common 40c., skilled, 60c.; Minnesota—common, 55c., skilled, 65c.; Indiana—common, 40c.

Pittsburgh—Wage disputes have caused strikes on the new postoffice and on the two lock and dam jobs being built on the Allegheny near the city.

New Orleans—Workers have returned to the Public Belt bridge after striking for higher wages, pending negotiations. Temporary scales provide for common, 35c., carpenters, 50 to 60c., hoist runners, 80 to 90c., ironworkers, 85c., all on a 40-hour week. These scales are between the amounts received when the strike became effective and those demanded by labor.

California—Rebating of wages is now a felony in the state, according to a new law.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

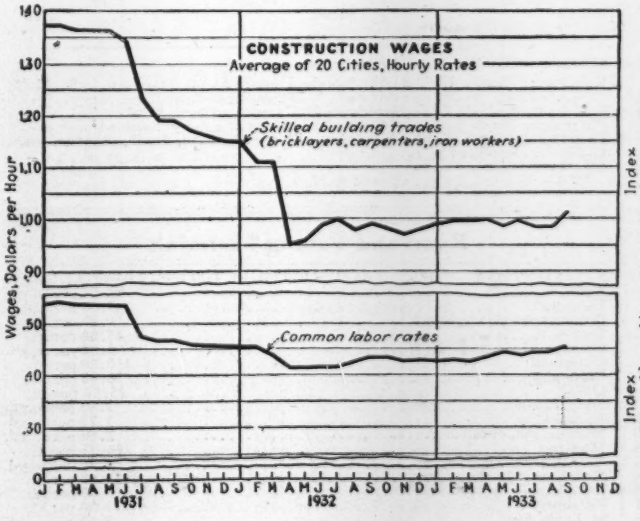
Cities	Bricklayers	Carpenters	Hoisting Engineers	Pile Drivers	Structural Iron Workers	Masons' Laborers	Common Laborers
Atlanta	$0.75@1.12½	$0.40@.90	$0.60@1.25	.....	$0.60@1.25	$0.25	$0.20@.25
Baltimore	1.00	.90	1.00@1.37½	$0.65	1.00@1.25	.40	.30
Birmingham	.75@.87½	.60	.75	.....	.75	.25	.20@.30
Boston	.90@1.30	.60@1.17½	.90@1.17½	.70@1.07½	1.20	.70	.45@.70
Cincinnati	1.27½	1.02½	1.07½	1.07½	1.20	.70	.40@.45
Chicago	1.37½	1.31¼	1.31¼	1.31¼	1.35	.88¾	.82½
Cleveland	.90@1.37½	.75@1.12½	.90@1.12½	1.00	.90@1.06¼	.56¼	.30@.72
Dallas	1.12½	.87½	.87½	.87½	.87½	.40	.40
Denver	1.00@1.12½	.75@.87½	.75@.87½	.....	.75@.87½	.50	.51¼@.50
Detroit	1.00	.70@.75	.75	.75	.80	.40	.35@.40
Kansas City	1.30	1.00	1.06	1.06	1.00	.70	.40@.60
Los Angeles	.75	.62½	.75	.75	1.00	.50	.40@.50
Minneapolis	.90@1.00	.75	.75	.....	.90	.50	.40@.50
New Orleans	1.00	.75	1.00	.70	1.25	.25@.40	.15@.25
New York	1.50@1.65	1.25@1.40	1.50@1.65	1.50	1.65	.81¼@1.00	.62½@.75
Philadelphia	.75@1.00	.50@.75	.75@1.00	.60@.75	.75@1.00	.20@.35	.20@.30
Pittsburgh	.60@1.50	.60@1.25	.60@1.37½	1.00@1.18¾	.60@1.37½	.50	.40@.70
St. Louis	1.50	1.25	1.35@1.47	1.25	1.47	1.00	.35@.78¾
San Francisco	1.12½	.90	1.00	1.00	1.20	.75	.65
Seattle	.75@1.20	.50@.90	1.00	.90	1.10	.66	.40@.50
Montreal	.75	.60	.55	.....	.70	.40	.20@.30

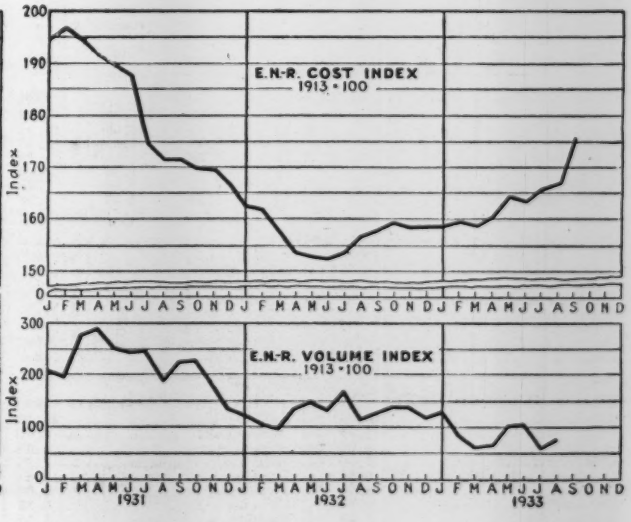
Skilled Average (3 trades) $1.016 Common Average, $0.452

ENR Cost and Volume Index

A heavy rise in the lumber component and an increase in common wage rates jumped the *ENR* Construction Cost Index from 167.00 in August to 175.48 in September, the largest monthly increase registered in eight years. The steel and cement components remained stationary. The Cost Index now stands at the same level as in June, 1931. The *ENR* Construction Volume Index rose to 73 for August from a low of 65 for July. The rise in costs retarded the Volume Index to some extent.

E.N.R.-Cost		E.N.-R. Volume	
September, 1933	**175.48**	**August, 1933**	**73**
August, 1933	167.00	July, 1933	65
September, 1932	157.96	August, 1932	111
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 (Average)	100		





Current Prices of Construction Materials

Building Materials

PORTLAND CEMENT — Prices are for carload lots. For cement in returnable cloth bags add 40c. per bbl.; in non-returnable paper bags add 15c. per bbl., to following net prices:

	F.o.b.	Delivered		F.o.b.	Delivered
Atlanta	$2.53	$3.10	Kansas City	$1.85	$2.10
Baltimore	....	2.03	Los Angeles	2.10	....
Birmingham	2.27	2.37	Minneapolis	2.45	2.60
Boston	2.12	2.32	Montreal	1.70	....
Chicago	1.85	2.20	New Orleans	1.90	2.20
Cincinnati	2.56	2.71	New York	2.13	2.45
Cleveland	2.02	2.07	Philadelphia	2.09	2.19
Dallas	2.30	2.45	Pittsburgh	2.12	2.57
Denver	2.65	2.81	St. Louis	1.74	2.15
Detroit	1.97	2.25	San Francisco	2.05	....
			Seattle	2.55	2.70

Current mill-prices per barrel to dealers, for carloads of 132 barrels or over, without including charge for four bags, f.o.b. Bag charges same as in preceding table:

Alpena, Mich	$1.65	Mason City, Ia	$1.70
Buffington, Ind	1.60	Norfolk, Va	1.76
Dallas, Tex. (Inc. 3c. tax)	1.80	Northampton, Pa	1.65
Hannibal, Mo	1.60	North Birmingham, Ala	1.75
Hudson, N. Y	1.75	Richard City, Tenn	1.70
Independence, Kan	1.70	Saginaw, Mich	1.65
Ironton, Ohio	1.60	Steelton, Minn	1.70
Iola, Kan	1.70	Universal, Pa	1.65
La Salle, Ill	1.60	Waco, Tex	1.75
Limedale, Ind	1.60	Wyandotte, Mich	1.60

SAND AND GRAVEL — Per ton, carload lots, gravel, size ¾-in.,

	Gravel		Sand	
	F.o.b.	Delivered	F.o.b.	Delivered
Atlanta	$2.11	$2.61	$1.65	$2.50
Baltimore	....	2.55	....	2.08
Birmingham, per cu.yd	....	3.00	....	2.40
Boston	1.50	1.75	1.00	1.25
Chicago, per cu.yd	....	2.25	....	2.25
Cincinnati	1.20	1.65	.95	1.40
Cleveland	....	2.00	1.40	2.00
Dallas, per cu.yd	1.40	2.50	1.65	2.10
Denver, per cu.yd	1.75	....	1.15	....
Detroit	.75	1.75	.75	1.45
Kansas City (at plant)	.65	....	.50	....
Los Angeles	1.45	1.60	1.00	1.10
Minneapolis	....	1.60	....	.75
New Orleans	1.40	2.40*	1.20	2.00*
New York, per cu.yd	1.50	3.25	1.00	2.00
Philadelphia	....	1.85	....	1.52
Pittsburgh	....	1.50	....	1.70
St. Louis	.80	1.40	.80	1.25
San Francisco	1.65	....	1.65	....
Seattle, per cu.yd	1.75	....	1.75	....

*Cu.yd.

CRUSHED STONE — Per ton, size 1½-in., carload lots, limestone:

	F.o.b.	Delivered
Atlanta	$1.50	$2.00
Baltimore	....	2.60
Birmingham	.80	1.05
Boston	1.50	1.75
Chicago, per cu.yd, 2,500 lb	....	2.25
Cincinnati	1.65	1.85
Cleveland	....	2.00
Dallas, per cu.yd., 2,500 lb	1.65	3.00
Denver, granite, per cu.yd., 2,700 lb	....	2.50
Detroit	....	2.00
Kansas City (at plant)	1.00	....
Los Angeles	1.45	1.60
Minneapolis	....	1.60
New York, per cu.yd., 2,800@3,000 lb	1.75	3.25
Philadelphia	....	2.20
Pittsburgh	....	2.25
St. Louis	1.05	1.65
San Francisco, trap rock	....	1.65
Seattle, per cu.yd., 3,000 lb	1.10	....

CRUSHED SLAG—Prices for carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Slag Sand
Birmingham	$0.90	$1.15	$2.05	$0.55
Buffalo	1.35	1.35	1.85	1.25
Cleveland	1.70	1.70	....	1.35
Toledo	1.20	1.20	1.20	1.10
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown	1.10	1.20	2.00	.75

CONCRETE BLOCKS—Standard, 8x8x16-in., hollow, delivered to job, each:

Baltimore (8x12x12)	$0.20	Kansas City	$0.18
Birmingham (5x8x12)	.084	Los Angeles	.15
Boston	.13	Minneapolis	.10
Brooklyn and Queens	.09	Montreal	.12
Chicago	.175	New Orleans	.16
Cleveland	.165	Philadelphia	.15
Denver	.15	Pittsburgh	.18
Detroit	.10	St. Louis	.14

READY MIXED CONCRETE—Per cu.yd., 1:2:4, delivered 50 cu.yd. or more:

Atlanta	$8.00	Los Angeles	$6.10
Birmingham	5.75	Minneapolis	6.00
Boston	6.00	New Orleans	6.05
Cleveland	7.50	New York (Manhattan)	7.75
Cincinnati	6.50	Philadelphia	6.84
Dallas	6.50	Pittsburgh	7.00
Detroit 1:2½:5	4.75	St. Louis	6.80
Kansas City	7.50	Seattle	5.35

HOLLOW TILE—Building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.09	$0.11	$0.13	$0.20	$0.25
Baltimore	.10	.14	.20	.22	.30
Birmingham	.089	.122	.167	.219	.25
Boston	.0975	.134	.1827	....	....
Chicago	.0484	.063	.09	.1179	.13
Cincinnati	.06815	....	....	.165	....
Cleveland	.048	.066	.09	.117	.13
Dallas	.091	....	....	.202	....
Denver	.085	.135	.175	.19	.25
Detroit	.0505	.065	.0947	.1175	.1305
Kansas City	.0735	.092	.15	.1777	.20725
Los Angeles	.085	....	....	.22	....
Minneapolis	.0692	.0988	.1372	.1447	.2029
New Orleans	.08	....	....	.22	....
New York	.076	.118	.147	....	....
Perth Amboy	....	....	....	.2388*	.2956*
Philadelphia	.065	.093	.14	.175	.195
Pittsburgh	.0435	.065	.088	.1165	.126
St. Louis	.06	.082	.112	.155	.19
San Francisco	.0765	.105	.1765	....	....
Seattle	.085	.115	.18	....	....

*At plant. (Load-bearing tile).

BRICK — Prices per thousand in carload lots, as follows:

	Common Backing		Paving
	F.o.b.	Delivered	F.o.b. 3x8½x4-in.
Atlanta	$9.00	$12.50	$32.00
Baltimore	....	13.00	43.00†
Birmingham	10.00	12.50	25.00
Boston	12.00	13.50	32.00
Chicago	....	9.00	32.00
Cincinnati	13.50	16.00	36.50
Cleveland	14.00	16.00	33.00
Dallas	13.50	15.50	25.00†
Denver	13.00	....	40.00
Detroit	....	11.50	35.25
Kansas City	12.00	14.00	35.00
Los Angeles	....	11.00	....
Minneapolis	....	7.50	....
Montreal	18.75	....	....
New Orleans	11.00	14.00	40.00
New York	9.50	12.50	47.50
Philadelphia	....	13.00	40.00
Pittsburgh	13.00	15.00	35.00
St. Louis	....	11.00	36.00†
San Francisco	....	14.00	45.00*
Seattle	12.00	14.00	....

*2½x8½x4 in. †3½x8½x4 in.

LIME — Prices of hydrated, per ton, in paper; lump, per 180-lb. bbl., net:

	Hydrated				Common Lump,	
	Finishing		Common			
	F.o.b.	Delivered	F.o.b.	Delivered	F.o.b.	Delivered
Atlanta	$17.50	$20.00	$11.50	$14.00	....	$2.50
Baltimore	....	21.00	....	14.00	....	....
Birmingham	21.00	....	12.00	....	$1.65	....
Boston	16.50	19.00	12.50	15.00	2.65*	3.50*
Chicago	....	20.00	....	14.00	....	2.75
Cincinnati	13.50	14.50	8.65	9.65	....	....
Cleveland	13.00	18.00	11.50	16.00	....	2.60
Dallas	....	20.00	....	....	....	2.50
Denver	....	30.00	....	22.00	....	2.85*
Detroit	....	20.00	....	16.00	....	....
Kansas City	19.00	20.00	....	20.00	....	2.75
Los Angeles	....	22.00	....	19.00	....	2.00
Minneapolis	....	25.50	....	21.00	....	1.70
Montreal	....	....	12.00	13.00	....	....
New Orleans	17.00	24.50	10.00	13.00	1.66	1.95
New York	14.20	18.00	11.10	15.00	2.65*	3.55*
Philadelphia	14.55	19.00	10.90	14.45	....	1.28
Pittsburgh	14.50	16.00	9.95	11.45	1.85	2.35
St. Louis	....	22.00	....	20.00	....	2.75
San Francisco	22.50	....	19.00	....	1.59	....
Seattle	....	32.00	....	24.00	....	2.80

*Per 280-lb. bbl. (net.)

LIMESTONE—Mill blocks, f.o.b. siding, per cu.ft.:

New York:* Rustic buff, $1.38; Standard gray, $1.48; Standard buff, $1.58; Selected gray, $1.58; Selected buff, $1.68; Variegated, $1.38.
Boston: Rustic buff, $1.47; Standard, $1.57; Selected buff, $1.67.
Pittsburgh: Rustic buff, $1.14; Standard, $1.24 at quarry; Selected buff, $1.34.
Philadelphia: Sel. buff, $1.59; Sel. gray, $1.49; Standard, $1.49; Standard gray, $1.39; Rustic buff, $1.39.
Atlanta: Standard $1.26.
*F.o.b. Bedford, freight allowed to N. Y

Road and Paving Materials

PAVING STONE — Granite, lots of 50,000 blocks, 4x8x4-in., dressed, f.o.b. city:

Atlanta	$3.00 per sq.yd.
Baltimore	43.00 per M.
Birmingham (3½x8½x4-in.)	76.25 per M.
Boston	65.00 per M.
Chicago, 5 in	3.80 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	96.00 per M.
Dallas	25.00 per M.
Detroit, 5 in	2.80 per sq.yd.
Kansas City	2.75 per sq.yd.
Minneapolis, 4½ in	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in	135.00 per M.
Philadelphia, 4x10x5	115.00 per M.
Pittsburgh	115.00 per M.
St. Louis, 5 in	2.80 per sq.yd.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING — Prices f.o.b., in carload lots:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.00
Chicago	3½	12	1.90
Kansas City	3½	16	2.75
Minneapolis	2½	8	1.65
Montreal	3½	16	2.63
New York	3½	14	2.05
Philadelphia	3½	16	2.02
St. Louis	3½	16	2.00

CURBING—Per lin.ft., 5x16 in., straight, rough, f.o.b., in carload lots:

Atlanta	$0.41	Kansas City	$0.60
Birmingham	.50	New York	.58
Boston	.60	Philadelphia (6x20 dressed)	1.40
Dallas	.60	Pittsburgh	.80
Detroit	.45	St. Louis	.80

ASPHALT—Paving asphalt, f.o.b., per ton. Packages are 350-lb. bbl. or 425-lb. drums, in carload lots:

	Packages	Tank-car or -boat
Atlanta	$21.60	$17.40
Baltimore	19.00	15.00
Birmingham	.....	11.00
Boston (f.o.b. Everett)	18.00	14.00
Chicago	22.50	15.50
Cincinnati (f.o.b. refinery)	18.00	14.00
Cleveland	18.00	14.00
Dallas	.....	27.00
Denver	27.50	.....
Detroit	18.29	14.29
Kansas City (f.o.b. refinery)	17.00	12.00
Los Angeles	16.50	10.50
Maurer, N. J. (Bermudes)	.....	26.00
Maurer, N. J. (Trinidad)	.....	22.00
Minneapolis (f.o.b. Twin Cities)	23.30	18.30
Montreal (f.o.b. factory)	18.66	13.00
New Orleans	17.00	13.00
New York	19.00	15.00
Philadelphia	17.00	11.00
Pittsburgh	25.00	16.00
St. Louis	21.70	17.70
San Francisco (f.o.b. refinery)	16.00	10.00
Seattle	21.10	16.00

LIQUID ASPHALT — Residual, hot application, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Atlanta	$0.0689
Baltimore	.06
Birmingham	.06
Boston (f.o.b. Everett)	.055
Cincinnati	.075
Dallas	.05
Kansas City	.05
Los Angeles	.05
Montreal at (refinery)	.09
New York	.06
Philadelphia	.08
Pittsburgh	.05
St. Louis	.07

EMULSIFIED ASPHALT — For penetration and surface treatment, per gal.:

Boston, applied	$0.145
Cincinnati, f.o.b.	.075
Los Angeles, applied	.13
Des Moines, applied	.14
New York, applied	.15
Philadelphia, applied	.15
St. Louis, applied	.13½
Seattle, f.o.b. refinery	.08

Iron and Steel

	Pittsburgh	Chicago	Birmingham
STRUCTURAL SHAPES AND PLATES, per 100 lb., base, carload lots	$1.60	$1.70	$1.75
CONCRETE REINFORCING BARS, ½ in., billet, per 100 lb., carload lots	1.75	1.75	1.75
SHEETS, per 100 lb., carload lots:			
Hot-rolled No. 10	1.65	1.90	1.80
Hot-rolled annealed No. 24	2.25	2.35	2.40
Galvanized No. 24	2.85	2.95	3.00
RIVETS per 100 lb., ½ in., structural, carload lots	2.50	2.60	2.40
SHEETPILING, per 100 lb., base, carload lots	1.90	2.05	.....
WIRE NAILS, per 100 lb., base, carload lots	2.10	2.10	2.30
HEAVY MELTING STEEL SCRAP, No. 1, per gross ton, at consuming point	13.75	10.50@10.75	8.25@8.75

TRIANGLE MESH—Plain, per 100 sq.ft., in carload lots:

Style Number	Size, In.	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
032	4x4	22	$0.94	$0.96
049	4x4	28	1.19	1.22
068	4x4	35	1.45	1.49
093	4x4	45	1.87	1.91
126	4x4	57	2.31	2.37
153	4x4	68	2.75	2.82
180	4x4	78	3.16	3.24
245	4x4	103	4.17	4.27
287	4x4	119	4.82	4.94
336	4x4	138	5.59	5.73
395	4x4	160	6.48	6.64
036P	4x8	17	.71	.73
059P	4x8	24	1.01	1.03

TRIANGLE MESH—*Continued*

Style Number	Size, In.	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
072P	4x8	31	1.27	1.30
097P	4x8	40	1.64	1.68
049R	4x8	24	1.01	1.03
067R	4x8	31	1.27	1.30
089R	4x8	40	1.64	1.68

WIRE ROPE—Discounts from manufacturers' list prices on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20 %
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35 %
"Special Steel" and extra strong cast steel, round strand rope	27½%

Discount 5 points less than discount for Eastern territory: California, Colorado, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Texas, Washington and Wyoming. Discount 10 points less than discount for Eastern territory: Arizona, Idaho, Montana and Utah.

EXPANDED METAL LATH—Per 100 sq.yd., painted, f.o.b., in carload lots 2.2 lb. per sq.yd., standard-mesh diamond lath:

Atlanta	$15.00	Los Angeles	$17.00
Birmingham	17.00	Montreal (2.5 lb.)	24.00
Boston	15.00	New Orleans	20.00
Chicago	10.60	New York	13.50
Cincinnati	11.00	Philadelphia	13.50
Dallas	18.00	Pittsburgh	13.50
Detroit	18.00*	St. Louis	19.00
Kansas City	18.00*	San Francisco	17.00
*Delivered.		Seattle	17.00

STEEL FREIGHT RATES — Per 100 lb., effective Dec. 3, 1931, on finished steel products in the Pittsburgh District, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes bolts, flat sheets (except planished), chains, etc.; 40,000 lb. per car:

Atlanta, 36,000 lb.	$0.60	Detroit	$0.285
Baltimore	.29	Kansas City	.59
Birmingham	.60	New Orleans, 36,000 lb.	.69
Boston	.42	New York, 40,000 lb.	.35
Buffalo	.255	Pacific Coast, 60,000 lb.	1.17*
Chicago	.36	Philadelphia	.31
Cincinnati	.285	St. Louis	.41
Cleveland	.205	St. Paul	.60
Denver	.92	* All rail.	

Railway Materials and Supplies

STEEL RAILS — Per gross ton, f.o.b.

	Pittsburgh	Birmingham	Chicago
Standard rails	$40.00	$40.00	$40.00
Light rails	30.00	30.00	30.00
Re-rolled rails	26.00	.....	27.00

RAILWAY TIES — Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In by 8½ Ft.
Boston	Oak, untreated	$1.00	.....
	Pine, untreated	.95	.....
	Pine, creosoted	1.50	.....
New York	Long-leaf sap pine, untreated	.80	$1.00
	Mixed oak, untreated	....	1.00
Birmingham	White oak, untreated	.75	1.50
	White oak, creosoted	1.40	1.45
	Southern pine, untreated	.35	.60
	Southern pine, creosoted	.95	1.35
Chicago	White oak, untreated	1.05	1.35
	Oak, empty cell, creosoted	1.40	1.80
	Oak, zinc treated	1.25	1.65
	Southern pine, creosoted	1.15	1.50
Los Angeles	Fir, untreated	.45	....
	Fir, creosoted	1.15	....
Philadelphia	Red oak, untreated	.95	1.15
	Red oak, creosoted	1.47	1.90
St. Louis	White oak, untreated	.95	1.40
	Red oak, untreated	.85	1.30
	Red oak, creosoted	1.22	1.80
	Sap pine or cypress, untreated	.75	1.10
San Francisco	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

TRACK SUPPLIES — Prices per 100 lb., f.o.b., for carload lots:

	Pittsburgh	Birmingham	Chicago
Angle bars	$2.55	$2.55	$2.75
Standard spikes	2.40	2.40	2.60
Tie plates	1.75	1.85	1.85
Track bolts	3.50	3.50	3.50

Pipe

WROUGHT STEEL PIPE — Discounts from standard list for delivery from warehouse, except at Pittsburgh, where prices are f.o.b. mill. List prices per ft. as follows: 1-in., 7¢.; 3-in., 76½c.; 3½-in., 92c.; 6-in., $1.92.

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Atlanta	52%	14.5%	50%	42%
Chicago	57.25%	44.71%	53.83%	41.29%
Cleveland	53.3%	42.3%	50.8%	37.8%
New York	56.14%	43.6%	52. 2%	40.18%
Philadelphia	57.28%	44.68%	53. 8%	41.80%
Pittsburgh	67½%	58½%	68½%	59½%
St. Louis	60%	50%	58%	48%

Current Prices of Construction Materials

Pipe—Continued

CAST-IRON PIPE — Prices per net ton, for bell and spigot pipe, Class B and heavier, f.o.b. in carload lots; gas pipe and Class A, $3.00 per ton extra:

	4-In.	6-In. and Over
Atlanta	$39.50	$36.50
Boston	44.00	41.00
Birmingham (Base)	35.00	32.00
Burlington (Base)	38.00	35.00
Chicago	43.50	40.50
Dallas	47.50	44.50
Los Angeles	43.50	40.50
New York	41.50	38.50
Philadelphia (rail delivery)	39.50	36.50
Pittsburgh	44.50	41.50
St. Louis	42.50	39.50
San Francisco	43.50	40.50

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.135	$0.21	$0.385	.....	$1.40.	.....	.....
Baltimore	.10	.30	.58	.....	1.93	.....	$6.50
Birmingham	.18	.30	.54	$1.02	1.95	$3.50	5.00
Boston	.18	.28	.54	2.00	2.80	4.68	7.175
Chicago	.18	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.0945	.....	.2835	.....	1.125	2.448	.....
Cleveland	.1575	.245	.4725	1.25	2.25	3.96	6.15
Dallas	.25	.....	.735	.....	2.80	.....	.....
Denver	.16	.23	.414	.816	1.44	.....	.....
Detroit	.18	.27	.54	1.325	2.25	3.80	.....
Kansas City	.21	.335	.52	1.00	1.90	3.80	.....
Los Angeles(f.o.b.)	.2175	.2825	.5085	1.1865	2.034	3.69	.....
Minneapolis	.15	.21	.415	.95	1.72	2.85	3.75
Montreal	.30	.45	.75	1.95	2.60	.....	7.20
New Orleans	.16	.....	.51	.....	1.90	.....	.....
New York	.1925	.301	.5805	1.35	2.43	3.888	5.535
Philadelphia	.081	.126	.243	.65	1.17	2.376	4.615
Pittsburgh	.09	.18	.27	.62	1.22	2.45	3.68
St. Louis	.09	.205	.369	.945	1.62	3.20	4.40
San Francisco	.175	.25	.45	1.05	1.80	3.00	4.50
Seattle	.175	.275	.54	1.20	2.00	3.00	5.50

CLAY DRAIN TILE—Per 1,000 lin.ft., f.o.b., in carload lots, 4 in.:

Atlanta	$50.00	Los Angeles	$60.00
Birmingham	50.00	New Orleans	40.00
Boston	55.00	New York	35.00
Chicago	40.00	Philadelphia	36.00
Dallas	75.00	Pittsburgh	80.00
Denver	75.00	St. Louis	40.00
Detroit	60.00	San Francisco	67.50
Kansas City	60.00	Seattle	45.00

Miscellaneous

LINSEED OIL—Raw, in 5-bbl. lots, per lb., f.o.b.:

Atlanta (per gal.)	$0.80	Minneapolis	$0.113
Birmingham	.066	Montreal (per gal.)	.51
Boston (per gal. delivered)	.93	New York	.106
Dallas (per gal.)	.84	Philadelphia	.075
Denver	.1355	Seattle (per gal.)	.69
Kansas City (per gal.)	.89	St. Louis	11.5
Los Angeles	.128	San Francisco (del)	.112

WHITE LEAD—In oil, per 100 lb. keg., f.o.b.:

Atlanta	$12.50	Montreal	$ 9.54
Birmingham	12.50	New Orleans	11.00
Boston	9.90	New York	11.00
Dallas	12.00	Philadelphia	9.90
Kansas City	11.50	Seattle	11.50
Los Angeles	10.75	St. Louis	11.00

CHEMICALS—Water, sewage treatment, road work, f.o.b., carlots, New York:

Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.75@2.00
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competion, per ton	19.50
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, in drums, f.o.b. works, per 100 lb.	1.65
Soda ash, 58%, in bags, per 100 lb.	1.17½
Sulphate of aluminum, in 100 lb. bags	1.25@1.40
Sulphate of copper, in bbl., per 100 lb.	3.75

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¼-in., 6-ft.; ½-in.; ¾-in., 4-ft., 5-in.; 1-in., 3-ft., 8-in.; 1¼-in., 2-ft., 5-in.; 1½-in., 1-ft., 8-in. Following prices are per lb. for ¼-in. and larger, delivered in 1,200 ft. coils:

Atlanta	$0.17	Kansas City	$0.22
Baltimore	.225	Los Angeles	.155
Birmingham	.20	Minneapolis (f.o.b.)	.155
Boston	.145	Montreal	.14
Chicago	.175	New Orleans	.165
Cincinnati (f.o.b.)	.21	New York	.17
Cleveland	.20	Philadelphia	.15
Dallas	.25	St. Louis	.145
Denver	.165	San Francisco	.145
Detroit	.195	Seattle	.155

BUILDING PAPER—Black, 50-lb. per roll of 500 sq.ft., in carloads, f.o.b., producing point $2.30

SLATERS FELT—In carloads, per roll, f.o.b., producing point $0.65

PREPARED ROOFING—Per square, f.o.b., in carload lots:

	Single Shingles*	Strip Shingles†	Rolls‡
Atlanta	$5.35	$5.00	$1.75
Boston	6.85	5.20	1.75
Dallas	4.75	4.54	2.25
Detroit	6.50	6.50	1.85
Montreal	6.40	6.20	2.68
New Orleans	5.50	5.40	1.95
New York	6.50	6.25	2.50
Philadelphia	4.40	4.20	1.65
Seattle	8.75	5.50	2.25
St. Louis	6.40	5.22	1.45

*Slate finish, sufficient to cover 100 sq.ft. ‡Slate surfaced, in rolls weighing 85 to 90 lb †4 in 1, hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—In carload lots, f.o.b.:

	Asphalt Felt, per 100 Lb.	Tar Felt, per 100 Lb.	Asphalt Coating per Gal	Tar Pitch,* per Ton
Atlanta	$44.50†	$44.50†	$0.47	$24.50
Boston	2.50	2.50	.66‡	23.00
Dallas	2.00	2.23	1.25	33.00
Montreal	2.62‡	2.02‡	1.40	1.63**
New Orleans	.....	2.50	.....	22.50
New York	2.40	2.40	.34‡	28.00
Philadelphia	2.25	2.25	.33	20.00
Seattle	2.40	2.40	.55	27.90
St. Louis	2.52	....	.28	26.00

*In 350 lb. barrels. †Per ton. ‡Per roll. **Per English cwt.

WINDOW GLASS—Discounts from latest jobbers list, dated Sept. 15, 1928 for sizes above first three brackets:

	Single Thickness		Double Thickness	
	A Quality	B Quality	A Quality	B Quality
Atlanta	85%	85%	85%	85%
Birmingham	89%	91%	89%	91%
Boston	88%	90%	87%	89%
Dallas	87%	89%	87%	89%
Denver	84@5%	86@5%	84@5%	86@5%
Kansas City	89@10%	89@10%	89@10%	89@10%
New York	87%	89%	87%	89%
Philadelphia	88%	90%	88%	90%
Pittsburgh	87%	89%	87%	89%
Seattle	90@10%	90@20%	90@10%	90@20%

EXPLOSIVES—Price per pound for dynamite delivered:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.215	$0.2375	Los Angeles†	$0.1725	$0.1925
Baltimore	.21	.225	Minneapolis	.1725	.1875
Birmingham	.15	.1725	Montreal	.1675	.1925
Boston	.27	.30	New Orleans	.19	.22
Chicago	.17	.195	New York	.245	.2675
Cincinnati (f.o.b.)	.22	.245	Philadelphia	.215	.24
Dallas	.24	.28	St. Louis	.1375	.1525
Denver	.19*	.205*	San Francisco	.1375	.1725
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

*F.o.b Louviers. †F.o.b. arsenal.

Lumber

LUMBER—Per M. ft., b.m., No. 1, Common, rough, in carload lots:

SOUTHERN YELLOW PINE

	1 x 6 In.*		1 x 8 In.*		3 x 12 In.†		12 x 12 In.†
	F.o.b.	Del.	F.o.b.	Del.	F.o.b.	Del.	F.o.b
Atlanta	$20.00	$22.50	$20.00	$22.50	$50.00	$57.00	$50.00
Baltimore	.....	46.00	.....	43.00	.....	.....	.....
Birmingham	40.00	50.00	40.00	50.00	50.00	60.00	55.00
Boston	30.00	35.00	31.00	36.00	65.00	70.00	65.00
Chicago	.....	.....	.....	.....	.....	62.50	.....
Cincinnati	.....	28.00	.....	28.00	.....	35.00	35.00
Cleveland	.....	22.00	.....	23.00	.....	30.00	32.00
Dallas	.....	35.00	.....	37.50	.....	65.00	65.00
Denver	.....	33.00	.....	33.00	.....	52.00	58.00
Detroit	30.00	32.00	30.00	32.00	32.00	32.00	45.00
Kansas City	.....	35.00	.....	38.00	.....	49.50	50.00
Minneapolis	.....	38.00	.....	38.00	.....	43.00	.....
Montreal	44.00	.....	45.00	.....	51.00	.....	.....
New Orleans	.....	18.00	.....	19.00	.....	30.00	.....
New York	33.00	35.00	33.50	35.50	66.00	68.00	66.00
Phil. No. 2(com.)	29.00	33.00	30.00	34.00	34.00	38.00	56.00
Pittsburgh	30.00	38.00	30.00	38.00	34.00	44.00	54.00
St. Louis	29.00	34.00	30.00	35.00	48.50	53.50	47.00

DOUGLAS FIR

	1 x 6 In.*		1 x 8 In.*		3 x 12 In.†		12 x 12 In.†
	F.o.b.	Del.	F.o.b.	Del.	F.o.b.	Del.	F.o.b
Baltimore	.....	$43.00	.....	$46.00	.....	$46.00	.....
Boston	$25.00	30.00	$28.00	33.00	$38.00	43.00	$38.00
Chicago	.....	.....	.....	.....	.....	44.52	.....
Cincinnati	.....	.....	.....	.....	.....	42.50	42.50
Cleveland	.....	24.50	.....	26.00	.....	32.50	34.00
Denver	.....	33.00	.....	33.00	.....	52.00	58.00
Detroit	.....	.....	.....	.....	30.00	30.00	45.00
Kansas City	.....	30.00	.....	33.00	.....	37.50	47.50
Los Angeles	30.00	31.50	30.00	31.50	31.00	32.50	32.00
Minneapolis	.....	38.00	.....	38.50	.....	45.00	.....
New Orleans	.....	21.00	.....	21.00	.....	42.50	.....
New York	30.50	32.50	31.00	33.00	37.00	39.00	40.00
Philadelphia	.....	.....	.....	.....	.....	36.00	39.00
Pittsburgh	.....	.....	.....	.....	46.00	58.00	47.00
St. Louis	34.00	39.00	34.00	39.00	35.00	40.00	35.00
San Francisco	.....	18.00	.....	19.00	.....	20.00	20.00
Seattle	19.50	20.50	19.50	20.50	21.50	22.50	22.50

*Form lumber, 16 ft. lengths. †Planks and timbers, 20 ft. lengths.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C., per lineal foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.09	$0.145
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.13	.195
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.15	.215
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.185	.225
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2025	.225
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.265	.375
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.305	.442